APPENDIX F

FLOW-HABITAT ASSESSMENT STUDY

FLOW-HABITAT ASSESSMENT STUDY

Prepared for:

RUSSIAN RIVER BIOLOGICAL ASSESSMENT EXECUTIVE COMMITTEE

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November 21, 2003

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Term	*Definition*
BA	Biological Assessment
BO	Biological Opinion
CDFG	California Department of Fish and Game
cfs	cubic feet per second
CEQA	California Environmental Quality Act
D1610	Decision 1610
ESA	Federal Endangered Species Act of 1973
fps	feet per second
ft	feet
HSC	Habitat Suitability Criteria
MCRRFCD	Mendocino County Russian River Flood Control and Water Conservation Improvement District
NMFS	National Marine Fisheries Service
NOAA Fisheries	National Oceanic and Atmospheric Administration Fisheries (formerly NMFS)
NCRWQCB	North Coast Regional Water Quality Conservation Board
RMA	Resource Management Associates
RRWQM	Russian River Water Quality Model
SCWA	Sonoma County Water Agency
SWRCB	State Water Resources Control Board
TRPA	Thomas R. Payne & Associates
USACE	U.S. Army Corps of Engineers
WSTSP	Water Supply and Transmission System Project

PURPOSE

This memorandum presents methods, results, and conclusions of a fish habitat study conducted jointly by the U.S. Army Corps of Engineers (USACE), Sonoma County Water Agency (SCWA), with NOAA Fisheries (formerly National Marine Fisheries Service [NMFS]), California Department of Fish and Game (CDFG), and North Coast Regional Water Quality Control Board (NCRWQCB).

The study evaluated habitat availability at alternative flow scenarios for juvenile and fry lifestages of three species of anadromous salmonids: coho salmon, steelhead, and Chinook salmon. The results of this study will be used to assess the relative value of different flow levels that may be incorporated as part of alternative operations scenarios in the process of developing the Biological Assessment (BA). In addition, spawning habitat for steelhead and Chinook salmon was evaluated for the Russian River, but not for Dry Creek. The study area included Dry Creek between Warm Springs Dam and the Russian River confluence, and the Russian River between the Forks and the City of Cloverdale. Habitat was evaluated over a range of releases from Warm Springs and Coyote Valley dams. Habitat quality and quantity were evaluated by a panel of biologists representing the agencies listed above.

BACKGROUND

SCWA, USACE, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) are undertaking a Section 7 Consultation under the federal Endangered Species Act (ESA) with NOAA Fisheries to evaluate the effects of their operations and maintenance activities on listed species and their critical habitat. These species are coho salmon, steelhead, and Chinook salmon. SCWA, USACE, and MCRRFCD operate and maintain facilities and conduct activities related to flood control, water diversion and storage, hydroelectric power generation, and fish production.

As part of the Section 7 Consultation, USACE and SCWA will submit to NOAA Fisheries a BA that will provide the basis for NOAA Fisheries to prepare a biological opinion (BO) that will evaluate project operations.

To evaluate flow-related habitat under the State Water Resources Control Board (SWRCB) Decision 1610 (D1610) and other potential flow regimes, the USACE and SCWA collaborated with NOAA Fisheries, CDFG, and the NCRWQCB to develop information regarding how fish habitat changes with flow. Minimum flow requirements for the Russian River and Dry Creek currently in place under D1610 were developed in consideration of studies conducted by Winzler and Kelley (1980) and Barraco (1977), water supply needs, recreational interests, and other factors. The information developed in this study will be used in evaluating the potential effects of various operating scenarios on salmon and steelhead habitat in the Russian River and Dry Creek. As agreed by NOAA Fisheries, USACE, and SCWA representatives, a semiquantitative analysis of flow-related habitat was developed. Study objectives centered on the current management of rearing habitat, which likely limits fish production in the study area.

Habitat availability was determined by considering a combination of field measurements at representative study sites (includes cross-sectional transects), observations by a team of professional fishery scientists, and qualitative analysis of the available habitat at different evaluation flows.

FLOW ASSESSMENT PROCESS

The new study was initiated with development and approval of a study plan during summer 2001. Under this study plan, an expert analytical team composed of NOAA Fisheries, CDFG, and SCWA biologists (collectively the "Panel") was assembled (see Attachment A). Habitat availability at a series of study sites in both Dry Creek and the Russian River was estimated at several flows designed to encompass various flow alternatives. Habitat would be evaluated based on the direct observation of habitat conditions and the professional opinions of these biologists.

The Panel estimated habitat availability at a series of representative study sites in both Dry Creek and the Russian River at alternative flows. Study sites were chosen as representative of available habitat in the Russian River and Dry Creek. Most transects were located in riffle or run habitat types. Habitat in pools would tend to have similar availability across a wide range of flows.

METHODS

REACHES AND FLOWS EVALUATED

Field data interpreted in this document were collected during September and October 2001. Two areas were evaluated, one in the Russian River and the other in Dry Creek. The Russian River reach extended from the confluence of the mainstem and the East Fork, downstream to the city of Cloverdale. Russian River sites were evaluated during stable dam releases of 125 cfs, 190 cfs, and 275 cfs. Flows were slightly lower at the more downstream sites, likely because of diversions from the reach for agricultural and municipal use. The Russian River evaluation reach was selected because under current flow management this area is believed to have suitable habitat for Chinook salmon and steelhead. Dry Creek was evaluated from Warm Springs Dam downstream to the confluence of the Russian River. Dry Creek provides habitat for coho salmon as well as Chinook salmon and steelhead. Dry Creek sites were evaluated during stable dam release flows of 47 cfs, 90 cfs, and 130 cfs.

PLACEMENT OF STUDY SITES

The Panel identified candidate sites based on local knowledge of Panel biologists and with the use of topographic maps and aerial photography. Final selections were made during on-site visits. These visits took place when flow in Dry Creek measured 178 cfs, and while flow in the Russian River measured 146 cfs. The vast majority of land along the Russian River and Dry Creek is privately owned; study sites were limited to areas where landowners' permission to access the streams could be obtained. Locations of study sites are presented in Figures 1 and 2 (see following pages).

Within each study site, a physical data transect was placed perpendicular to the major axis of flow and marked with rebar headpins. Study sites typically extended up to 100 feet upstream and downstream of the transect. Study sites typically encompassed both riffle and run habitat, and shallow pools. Nine sites were selected on Dry Creek and thirteen sites on the Russian River. Study sites were numbered consecutively starting at the upstream end of the Dry Creek evaluation reach (Sites 1-9), and again starting at the upstream end of the Russian River evaluation reach (Sites 1-13).

COLLECTION OF PHYSICAL DATA

Physical data were collected at each transect, as directed by the Panel. At all transects, channel cross-sections were surveyed using standard methods. Elevations were established relative to semi-permanent benchmarks placed by the survey team. Data describing in-channel substrates, mean column water velocities, and water depths were collected at 10 to 25 points across each transect. This information, along with habitat suitability indices (see "*Selection of Habitat Suitability Indices,*" below) were used by Panel members as estimates of habitat availability.

SELECTION OF HABITAT SUITABILITY INDICES

The suitability of depths and velocities for the different species and lifestages were evaluated using habitat suitability criteria (HSC) developed for this study prior to the onset of field observations. These criteria define the relative value or suitability of different depths and mean column velocities to a particular species and lifestage. For this study, the criteria described the range of optimal, suitable, and unsuitable depths and velocities for fry and juvenile coho salmon, steelhead, and Chinook salmon, and for steelhead and Chinook salmon spawners. The criteria were developed based on a compilation of HSC developed for these species/lifestages from other California streams, including Battle Creek (TRPA 1991), the Mokelumne River, the Trinity River (Hampton 1988), and the Yuba River (Lower Yuba River Fisheries Management Plan, CDFG 1991).

To develop the criteria for this study, HSC from the reference studies were combined and plotted on a single graph. The outer boundaries of the overlain reference criteria were then identified, providing what is referred to as an "envelope" curve. The envelope curve encompasses the entire area of the overlain curves. In one or two instances, the resulting curves were modified based on the professional judgment of the Panel, so that the envelope was slightly narrowed. From these envelope criteria, mean column velocity and depth values that exceeded a suitability of 0.5 were considered *optimal*, mean column velocity and depth values with a suitability exceeding 0.1 were considered *suitable*, and mean column velocity and depth values with a suitability of less than 0.1 were considered *unsuitable* (Attachment B).

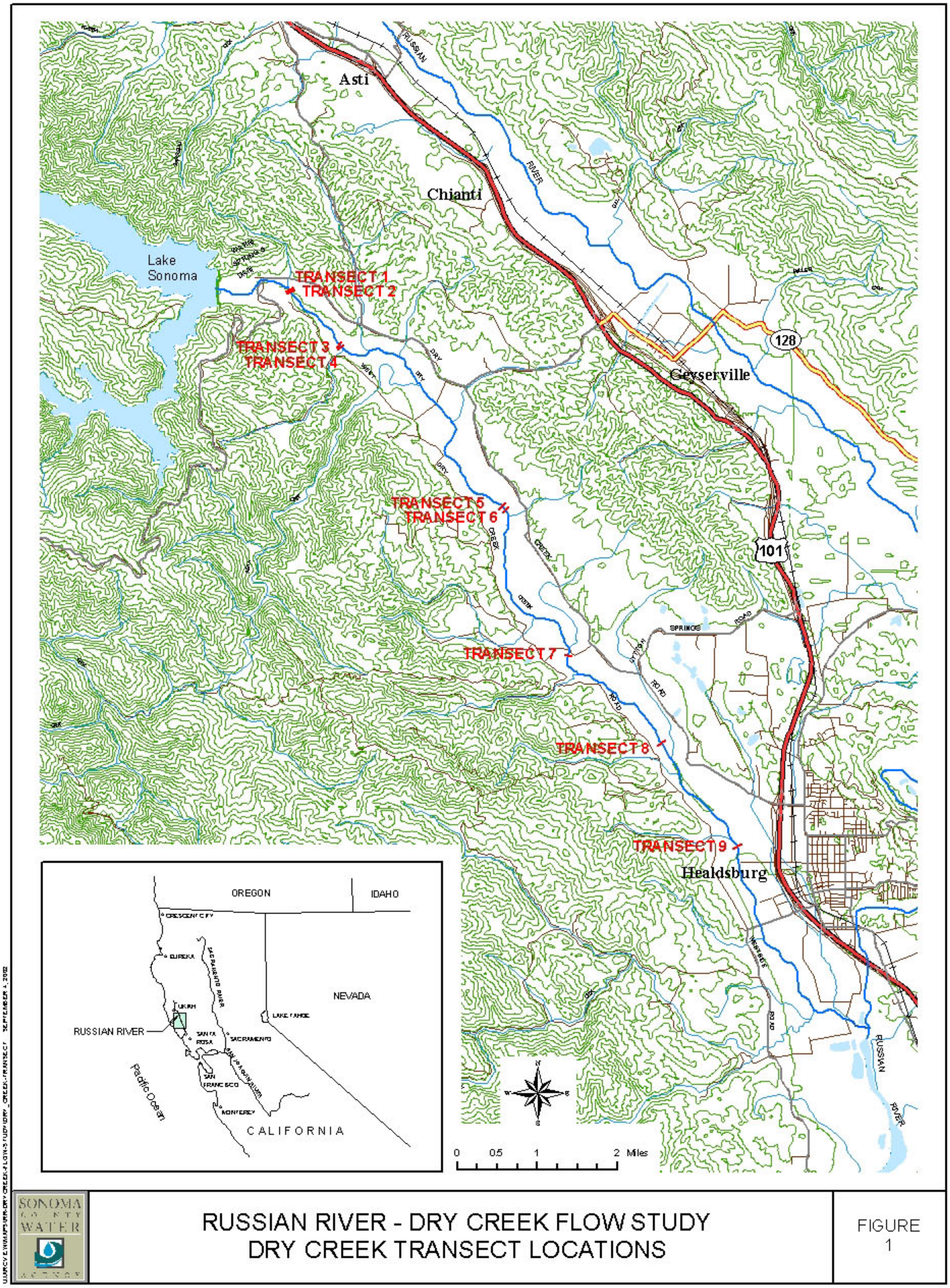

Figure 1 Russian River – Dry Creek Flow Study Dry Creek Transect Locations

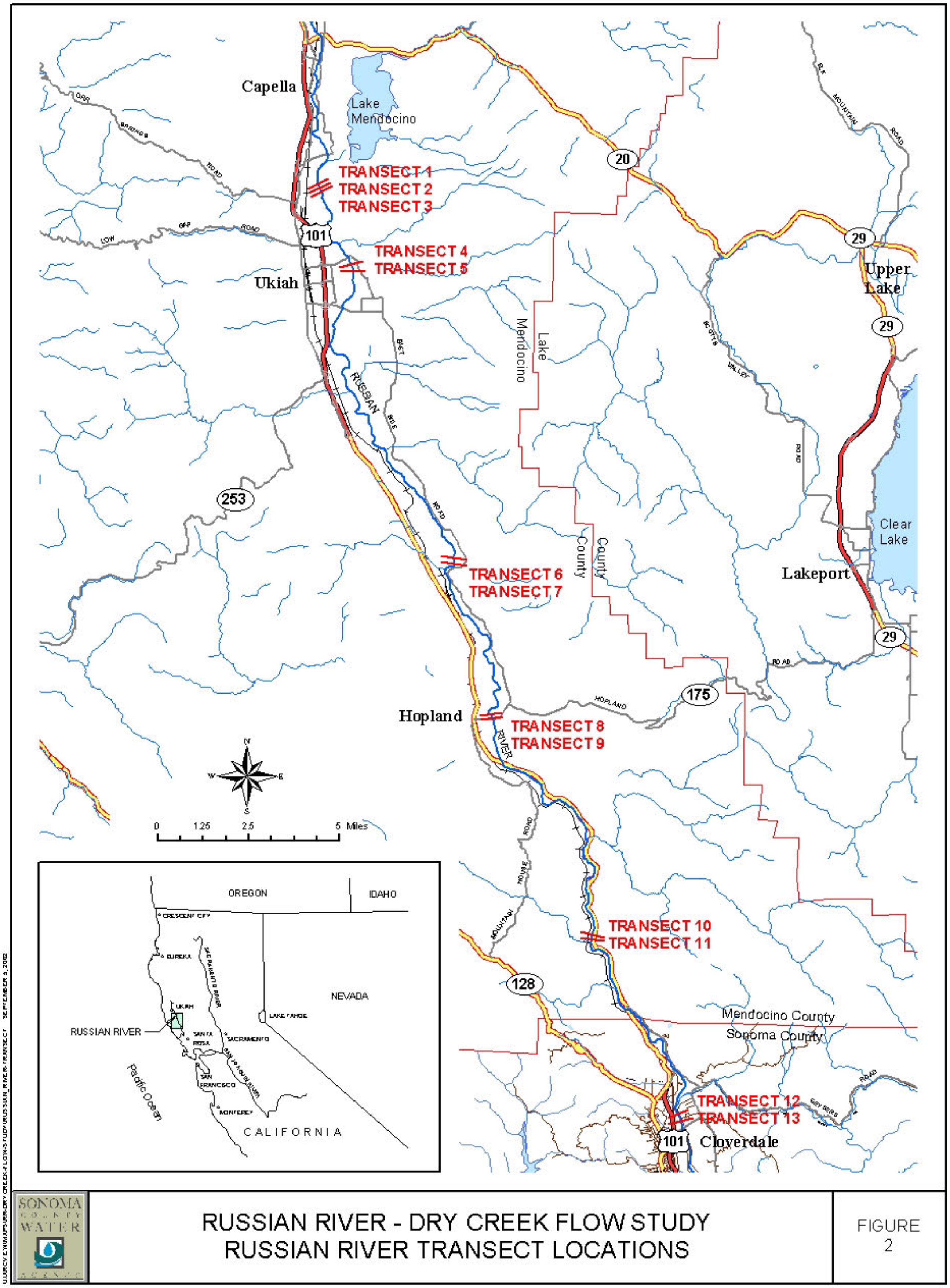

Figure 2 Russian River – Dry Creek Flow Study Russian River Transect Locations

The mean column velocity and depth criteria were used by the Panel as guidelines in estimating the availability of habitat for each species and lifestage at each study site. The criteria were not used quantitatively, but rather to provide perspective to the Panel during their assessments at each site. The evaluation of habitat availability in a particular location integrated additional factors as described in the following section.

PROFESSIONAL JUDGMENT/ASSESSMENT PROTOCOL

Field procedures for the assessment Panel involved observations of Dry Creek at nine study sites during three flow releases and comparable evaluations of the Russian River at thirteen study sites during three flow releases. The Panel followed the same route during observations for each flow, starting at the most upstream site and progressing downstream. During the first study flow (the lowest), substrate composition and cover conditions were observed, and study site boundaries were marked with flagging tape. At each flow, the Panel waded portions of the site where possible, and visually estimated approximate depths and velocities for principal sections of the site. The Panel then identified those areas likely to provide suitable habitat for each evaluation lifestage based on the HSC and other factors including adjacency to food-producing areas, influence of edge habitat, species interaction, vulnerability to predators, and channel/floodplain condition.

Estimates of habitat availability were articulated in terms of percent wetted area, as wetted area increased minimally across the range of flows studied. Team consensus was facilitated by limiting estimates to the following percent ranges: <10 percent, 10-25 percent, 25-40 percent, 40-60 percent, 60-80 percent, and >80 percent. When the Panel was unable to reach consensus on a score, a majority score was recorded, as well as the scores and names of minority dissenters.

RESULTS

The following sections summarize the results of the evaluation for Dry Creek and the Russian River. Observations at each flow, for each study site, are described in Attachment C. Attachment D provides cross-sectional plots of each of the physical data transects. Attachment E contains depth and mean column velocity measurements for each evaluation flow, and a summary of hydraulic statistics.

DRY CREEK

Habitat availability and quality was observed to vary with flows. In general, the lowest flow provided the greatest amount of suitable and optimal habitat (Tables 1 and 2). In some instances, habitat for particular species and lifestages increased as flows increased from low to intermediate levels (sites 1, 4, 5, and 7). In these cases, habitat was gained as water of sufficient depth flooded beneath overhanging vegetation or into channel-margins with appropriate physical characteristics. In some cases, increased habitat at intermediate flows resulted from situations where habitat with adequate depth and cover lacked sufficient velocities until flows rose above the low discharge.

Study sites were selected to represent habitat throughout Dry Creek, and were predominantly located in riffle and shallow run habitat, the most common habitats. Shallow pools were also included within the study sites. Larger pools also occur in Dry Creek, but are relatively rare. This habitat was not evaluated, and the results of this study may overstate changes in habitat availability in these less flow-responsive areas.

Rearing Habitat

Chinook Salmon

Suitable habitat for Chinook salmon was provided at all locations throughout the evaluation reach, and was most abundant at sites 1, 5, and 8 during low and intermediate flows. In these locations, water flowed smoothly across broad deposits of gravel and small cobble, affording these fry and small juveniles a useful combination of resting areas nestled among feeding lanes. In contrast, at the highest flow, much less habitat for Chinook salmon fry and juveniles was available (Tables 1 and 2).

Table 1 Number of Dry Creek Study Sites with the Greatest Amount of Optimal Habitat for Selected Salmonid Lifestages (comparing releases at 47 cfs, 90 cfs, and 130 cfs)

Optimal Habitat at Dry Creek				
Life Stage	Flow (cfs)			Flows with similar high scores
	47	90	130	
Chinook Fry	2	1	0	2 sites similar at 47 and 90 cfs, 4 sites similar at all 3 flows.
Chinook Juvenile	1	2	0	4 sites similar at 47 and 90 cfs, 2 sites similar at all 3 flows.
Coho Fry	1	0	1	1 site similar at 47 and 90 cfs, 6 sites similar at all 3 flows.
Coho Juvenile	1	1	0	7 sites similar at all 3 flows
Steelhead Fry	5	1	0	1 site similar at 47 and 90 cfs, 2 sites similar at all 3 flows.
Steelhead Juvenile	4	2	0	1 site similar at 47 and 90 cfs, 1 site similar at 90 and 130 cfs, 1 site similar at all 3 flows.

Table 2 Number of Dry Creek Study Sites with the Greatest Amount of Suitable Habitat for Selected Salmonid Lifestages (comparing releases at 47 cfs, 90 cfs, and 130 cfs)

Suitable Habitat at Dry Creek				
Life Stage	Flow (cfs)			Flows with similar high scores
	47	90	130	
Chinook Fry	1	1	0	4 sites similar at 47 and 90 cfs, 3 sites similar at all 3 flows.
Chinook Juvenile	1	2	0	5 sites similar at 47 and 90 cfs, 1 site similar at all 3 flows.
Coho Fry	1	1	1	2 sites similar at 47 and 90 cfs, 4 sites similar at all 3 flows.
Coho Juvenile	2	2	0	5 sites similar at all 3 flows.
Steelhead Fry	8	0	0	1 site similar at all 3 flows.
Steelhead Juvenile	4	0	1	3 sites similar at 47 and 90 cfs, 1 site similar at all 3 flows.

The data indicate that the low and intermediate flow levels provided similar amounts of habitat for Chinook salmon fry and juveniles. Fry habitat appears to have been somewhat more abundant at the low flow, while juvenile habitat appeared to be more abundant at the intermediate flow.

Coho Salmon

Within Dry Creek study sites, there was little habitat available for coho salmon. This lack of habitat arises from the poor channel structure (general lack of deep pools), and the lack of woody debris. These features constrain habitat for both fry and juvenile coho salmon. Flows are only indirectly related to this problem. This is evidenced by the fact that many of the sites showed little change in suitable and optimal habitat availability regardless of flow. At those sites where habitat did vary with flow, the high flow provided more fry habitat at two sites, while the middle and low flows each provided more fry habitat at one site each. Juvenile habitat was most abundant at three sites at the middle flow and at one site at the low flow. Pools with abundant cover are the habitat most favored by coho salmon. Pools do not represent a large portion of the habitat in Dry Creek. Therefore, under present conditions, Dry Creek provides limited amounts of habitat for coho salmon regardless of flow level.

Steelhead

Habitat for steelhead was generally more available at the low flow than at the intermediate or high flows (Tables 1 and 2). This was particularly true for steelhead fry, where eight of the nine sites provided more habitat at the lowest flow level, and only one site provided more habitat at the intermediate flow level. The highest study flow provided much less habitat for both fry and juveniles.

Habitat availability for steelhead was greater than that for Chinook salmon, and much greater than that for coho salmon. Quality habitat was found throughout the evaluation reach. Fry habitat was most abundant at Sites 1, 6, and 8, and juvenile habitat was most abundant at Sites 2, 3, 6, and 8. Generally, steelhead fry habitat overlaps that of Chinook salmon fry, but the stronger-swimming steelhead fry also make use of higher velocity areas than Chinook salmon fry. As steelhead grow beyond the fry lifestage, and into their first and then second years of life as juveniles, their habitat requirements shift toward deeper, faster areas of the stream. At the same time, instream cover provided by larger substrate particles, woody debris, water depth, or surface turbulence becomes more important. Habitat with adequate depth and velocity is provided in areas of Dry Creek even as flows increase to the highest level studied, but habitat complexity is low.

Factors Other Than Flow

Several factors limiting habitat availability in Dry Creek are independent of flow, or relate only indirectly to low-flow releases. Channel incision and loss of functional floodplains have resulted in a relatively narrow, and steep channel – often with precipitous banks. In reaches confined by bank protection efforts, the stream has little opportunity to meander, and has decreased sinuosity. Flood control operations associated with Warm Springs Dam have greatly altered the frequency, timing, duration, and magnitude of high flow events. Relatively stable summer flows, in concert with attenuated flood flows, have encouraged encroachment by willows and other riparian plants. Habitat diversity is low, and the availability of fish habitat decreases as flows rise.

Water temperatures, as predicted by the Russian River Water Quality Model (RRWQM), suggest that although summer water temperatures are warmer than optimal (>15.6°C) for salmonids in reaches of Dry Creek near the Russian River confluence (RMA 2002), they are almost always less than 19°C and therefore are still suitable for rearing. Closer to Warm Springs Dam, water temperatures are near optimal levels throughout the year, as releases are drawn from cool depths of the reservoir. In the more downstream reaches of Dry Creek, temperatures may be somewhat stressful but are not at levels considered extremely stressful.

RUSSIAN RIVER

Rearing Habitat

Habitat availability in the study sites was observed to vary with flows, and was moderately abundant overall at low and intermediate flows. At Sites 1, 4, 5, 7, 9, 10, and 11, habitat rated as high as 40-60 percent suitable for at least one species/lifestage at low flows, intermediate flows, or both. At Sites 2, 3, and 6, availability of habitat ranged no higher than 10-25 percent suitable for any species/lifestage at any flow; in general, habitat availability was greatest at the lowest flow and decreased gradually as flows increased. The availability of optimal habitat for fry and juvenile lifestages of steelhead and Chinook salmon is substantially reduced at the highest study flow (release of 275 cfs) as compared to conditions at lower study flows.

An exception occurred at Site 7, where habitat peaked during high flows, which provided 40-60 percent suitable habitat for all species/lifestages. This habitat was provided as water of sufficient depth flooded areas with gravel substrates, and where water of sufficient velocity carried into areas with unsuitably low velocities at lower flows. At this study site, optimal habitat was no greater than 10-25% for any of the evaluation species/lifestages at any flow (Table 4C – Attachment C).

Table 3 Number of Russian River Study Sites with the Greatest Amount of Optimal Habitat for Selected Salmonid Lifestages (comparing releases at 125 cfs, 190 cfs, and 275 cfs)

Optimal Rearing Habitat at Russian River				
Life Stage	Flow (cfs)			Flows with similar high scores
	125	190	275	
Chinook Fry	7	1	0	2 sites similar at 125 and 190 cfs, 3 sites similar at all 3 flows.
Chinook Juvenile	6	1	0	2 sites similar at 125 and 190 cfs, 1 site similar at 190 and 275 cfs, 3 sites similar at all 3 flows.
Steelhead Fry	8	1	0	1 site similar at 125 and 190 cfs, 3 sites similar at all 3 flows.
Steelhead Juvenile	4	2	1	1 site similar at 125 and 190 cfs, 5 sites similar at all 3 flows.

Table 4 Number of Russian River Study Sites with the Greatest Amount of Suitable Habitat for Selected Salmonid Lifestages (comparing releases at 125 cfs, 190 cfs, and 275 cfs)

Suitable Rearing Habitat at Russian River				
Life Stage	Flow (cfs)			Flows with similar high scores
	125	190	275	
Chinook Fry	10	0	1	1 site similar at 125 and 190 cfs, 1 site similar at all 3 flows.
Chinook Juvenile	8	1	1	1 site similar at 125 and 190 cfs, 2 sites similar at all 3 flows.
Steelhead Fry	11	1	1	All sites with a peak value
Steelhead Juvenile	6	1	2	1 site similar at 125 and 190 cfs, 1 site similar at 125 and 275 cfs, 2 sites similar at all 3 flows.

Study sites were chosen that were representative of riffle and run habitat in the Russian River study segment. Sites 2, 11, and 13 did contain pool habitat.

Chinook Salmon

The lowest flow provided the most habitat for Chinook salmon fry at 10 of the 13 study areas. Site 2 provided greater amounts of optimal habitat at the intermediate flow level, and Site 7 provided greater amounts of suitable habitat at the high flow level. There was very little optimal habitat at Site 7 at any flow. Availability of habitat for fry was highest at sites 1, 4 and 5. At these sites, water flowing smoothly across suitable substrates provided feeding and resting areas for fry.

For juvenile Chinook salmon, the lowest flow provided the greatest amount of suitable and optimal habitat at 8 of 13 sites (Tables 3 and 4, Table 4C - Attachment C). At Sites 2 and 4, the intermediate flow provided the most habitat. The other two sites had similar amounts of habitat at two of the three flows. Sites 1, 4, 5, 10, 11, and 12, provided the most habitat for juvenile Chinook salmon. At Sites 10 and 11, the channel was dramatically more complex than elsewhere in the Russian River. Complex velocity patterns, highly diverse and well-sorted substrates, and variable water depths provided a rich mosaic of fish habitat. Early lifestages of Chinook salmon are most often associated with low-to-zero velocity habitats. Often the margin of slow runs, as well as areas in pools, provide habitat used by these small and relatively weak-swimming salmon.

Steelhead

The lowest flow provided the greatest amount of suitable and optimal habitat for steelhead fry at 12 of the 13 sites (Tables 3 and 4, Table 4C - Attachment C). Site 2, the only exception, provided slightly more habitat at the middle flow. The lowest flow provided the greatest amount of suitable and optimal habitat for juvenile steelhead at 6 of the 13 sites (Tables 3 and 4). At three other sites, the low and intermediate flows provided about the same amount of habitat for this species/lifestage. Only Site 2 had the greatest amount of habitat at the middle flow, while Site 4 had the greatest amount of habitat at the high flow level. Availability of optimal habitat for fry and juvenile lifestages are appreciably reduced at the highest flow (275 cfs) relative to the lower study flows.

For Chinook salmon, the channel complexity observed at Sites 10 and 11 provided a rich mosaic of habitat for fry and juvenile steelhead that was unavailable in other portions of the river.

Spawning Habitat

Releases of 190 cfs provided the greatest amount of suitable habitat for Chinook salmon and steelhead spawners (Table 6). Spawning habitat was concentrated at six sites: 3, 5, 6,10, 11, and 12. Of these sites, the three upstream sites were estimated to provide approximately twice as much habitat (for both species, up to 40-60 percent suitable, and up to 25-40 percent optimal) as the three downstream sites (up to 10-25 percent suitable and optimal for both species). At Site 1, habitat availability was moderate for steelhead spawning (as high as 25-40 percent suitable, 10-25 percent optimal) and for Chinook salmon spawning (10-25 percent suitable, <10 percent optimal), but changed very little with flow. At the remaining sites, habitat availability was low, ranging no higher than 10-25 percent suitable and <10 percent optimal at any flow (Table 5C – Attachment C).

Table 5 Number of Russian River Study Sites with the Greatest Amount of Optimal Spawning Habitat for Selected Salmonid Lifestages (comparing releases of 125 cfs, 190 cfs, and 275 cfs)

Optimal Spawning Habitat at Russian River				
Life Stage	Flow (cfs)			Flows with similar high scores
	125	190	275	
Chinook Spawners	0	5	1	2 sites similar at all 3 flows, 5 sites with 0 values at all 3 flows.
Steelhead Spawners	2	3	0	1 site similar at 125 and 190 cfs, 2 sites similar at all 3 flows, 5 sites with 0 values at all 3 flows.

Table 6 Number of Russian River Study Sites with the Greatest Amount of Suitable Spawning Habitat for Selected Salmonid Lifestages (comparing releases of 125 cfs, 190 cfs, and 275 cfs)

Suitable Spawning Habitat at Russian River				
Life Stage	Flow (cfs)			Flows with similar high scores
	125	190	275	
Chinook Spawners	0	5	0	2 sites similar at 125 and 190 cfs, 2 sites similar at 190 and 275 cfs, 1 site similar at 125 and 275 cfs, 1site similar at all 3 flows, 3 sites with 0 values at all 3 flows.
Steelhead Spawners	1	3	0	4 sites similar at 125 and 190 cfs, 1 site similar at 190 and 275 cfs, 1 site similar at 125 and 275 cfs, 2 sites similar at all 3 flows, 1 site with 0 values at all 3 flows.

Factors Other Than Flow

Much of the Russian River study area appeared to provide suitable habitat for supporting juvenile steelhead throughout the year and juvenile Chinook salmon through June. For the most part, habitat is of low-to-moderate complexity, except in the vicinity of Cominsky Station (Sites 10 and 11), where the channel changes dramatically. Here, the gradient steepens, sediment sizes increase, large woody debris helps to provide cover, and the quality of habitat is high. During July and August, water temperatures may warm to 20 to 22°C. These temperatures are considered somewhat stressful, but still suitable for rearing provided adequate food is available. This may slightly offset benefits of improved channel structure.

It was apparent during this study that factors unrelated to flow levels affect salmonid habitat in the Russian River. Operation of Coyote Valley Dam, flood control-related "channel maintenance" projects, land management, historical aggregate mining, imports of water from the Eel River, and other factors all influence the quality of habitat in the evaluation reach. At Sites 1, 2, 3, 4, and 5, channelbed margins transition abruptly to precipitous banks. Nonetheless, juvenile salmonids are present in this area, and may be fairly abundant. During a weekend site visit by a member of the Panel, casual hook-and-line sampling resulted in multiple landings of juvenile Age 1+ and Age 2+ steelhead.

In many places, riparian vegetation has encroached along one or both banks. Fine sediment is abundant in substrates both near the top and bottom of the evaluation reach. Habitat diversity is low at many sites, and fish habitat is less abundant as flows rise. This occurs because the channelized nature of the river prevents the river from spreading out when flows increase. This, in combination with the lack of bed complexity and large woody debris, causes velocities to increase substantially as flows rise.

DISCUSSION

Generally speaking, the lower flow levels observed seemed to provide greater amounts of suitable and optimal habitat than the higher flow levels. On Dry Creek this was particularly true for steelhead fry and juveniles. The low and intermediate flow levels on Dry Creek provided similar amounts of habitat for fry and juvenile Chinook salmon. The amount of habitat at the 130 cfs flow level on Dry Creek provided much less suitable and optimal habitat for both species than either of the two lower flows. In most Dry Creek study sites, at least 25 percent of the stream area provided optimal habitat for steelhead fry and juveniles when flows were either 47 cfs or 90 cfs (see Attachment Table 2C); most of these cases occurred at the lowest flow. Dry Creek also provided ample nursery habitat for Chinook salmon; at least 25 percent of the stream area was rated optimal at flows of 47 cfs and 90 cfs (see Attachment Table 2C).

On the Russian River, the lowest observed flow provided the greatest amount of habitat for both Chinook salmon and steelhead fry and juveniles. The intermediate flow provided the greatest amount of habitat for spawners of both species. On the Russian River the difference in the amount of habitat was more similar among the three flow levels and there was not the tremendous decrease in habitat at the highest flow level as was observed in Dry Creek.

The Panel looked at how rearing habitat changed with flow in study sites representative of habitat throughout evaluation reaches in the Russian River and Dry Creek. Habitat in the Russian River and Dry Creek has been negatively impacted by management practices including: removal of instream woody debris, bank armoring for erosion control, operation of dams, and aggregate mining within channels. These practices have contributed to factors such as channel incision and riparian encroachment. These aspects of habitat are not integrated into this study and correction of some of the problems resulting from these activities may also improve habitat.

Today, the active channel in some areas is poorly connected to the floodplain due to down-cutting; this is especially an issue in Dry Creek. In reaches where incision has occurred, rising flows do not spread across gently-sloping channel margins and adjacent floodplain surfaces. Instead, stage rises rapidly and velocities increase quickly in comparison to what occurred in the historical channel, where relatively abundant meanders and point bars supported favorable conditions for salmon and steelhead across a wider range of flows. Historical aggregate mining practices have contributed to channel incision.

Flood control operations have altered the frequency, timing, duration, and magnitude of high flow events. Relatively stable summer flows, in concert with attenuated flood flows, have encouraged damaging encroachment by even-age stands of willows, alders and other woody riparian plants; this is especially true in Dry Creek.

Habitat quality in portions of Dry Creek and the Russian River may be reduced seasonally by warm water temperatures under current flow management conditions (RMA 2002). Near Coyote Valley Dam, Russian River water temperatures are suitable through the summer, but frequently rise to more stressful levels in September or October once releases have exhausted the cool-water pool. This event overlaps with the time of year when air temperatures decline and thus the rise in water temperature is partially mitigated. Summertime temperatures appear adequate for Chinook salmon (present through June) and steelhead as far downstream as Cloverdale. In late winter through spring, water temperatures are excellent throughout the mainstem Russian River, and habitats near Healdsburg should support pre-smolts and smolts during seaward migrations.

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ATTACHMENT A

FLOW STUDY PARTICIPANTS

Attachment A. Flow Study Participants in the Russian River/Dry Creek Flow Study.

Date	Release (cfs)	Locations	Number of Transects	Participants*
9/13/01	47	Dry Creek	9	JB, BC, TD, RF, AH, BH, PL., SL, SW
9/19/01	90	Dry Creek	9	JB, BC, RF, AH, BH, PL, SL, SW
9/20/01	130	Dry Creek	9	JB, BC, TD, RF, AH, BH, SL, SW
9/26/01	125	Russian River	13	BC, RF, AH, BH, PL, SL, TT, SW
10/1/01	190	Russian River	13	BC, TD, RF, AH, PL, SL, TT, SW
10/4/01	275	Russian River	13	BC, TD, RF, AH, PL, SL, TT

*Flow Panel	Affiliations
Jean Baldrige (JB)	ENTRIX
Bill Cox (BC)	CDFG
Tom Daugherty (TD)	NOAA
Robert Franklin (RF)	ENTRIX
Amy Harris (AH)	SCWA
Bill Hearn (BH)	NOAA
Peter LaCivita (PL)	USACE
Stacy Li (SL)	NOAA
Tom Taylor (TT)	ENTRIX
Sean White (SW)	SCWA

ATTACHMENT B

HABITAT SUITABILITY CRITERIA

Attachment B. Suitability Criteria for Russian River Target Species: Range of Depths and Velocities for Coho Salmon, Steelhead, and Chinook Salmon

Fry

Coho Salmon	Not Suitable	Acceptable	Optimal	Acceptable	Not Suitable
Depth (ft)	<0.3	0.31-0.49	0.5-1.7	1.71-2.5	>2.5
Velocity (fps)	-	0.0-0.1	0.11-0.6	0.61-1.0	>1.0

Steelhead	Not Suitable	Acceptable	Optimal	Acceptable	Not Suitable
Depth (ft)	<0.15	0.15-0.18	0.19-1.2	1.21-1.8	>1.8
Velocity (fps)	-	0.0-0.29	0.3-1.1	1.11-2.0	>2.0

Chinook Salmon	Not Suitable	Acceptable	Optimal	Acceptable	Not Suitable
Depth (ft)	<0.15	0.15-0.44	0.45-2.0	2.01-2.8	>2.8
Velocity (fps)	-	-	0.0-0.6	0.61-1.1	>1.1

Juveniles

Coho salmon	Not Suitable	Acceptable	Optimal	Acceptable	Not Suitable
Depth (ft)	<.03	0.3-0.49	0.5-1.7	1.71-2.5	>2.5
Velocity (fps)	-	0.0-0.1	0.11-0.6	0.61-1.0	>1.0

Steelhead	Not Suitable	Acceptable	Optimal	Acceptable	Not Suitable
Depth (ft)	<0.4	0.4-0.69	0.7-2.5	2.51-3.3	>3.3
Velocity (fps)	-	0.0-0.09	0.1-2.0	2.11-3.0	>3.0

Chinook salmon	Not Suitable	Acceptable	Optimal	Acceptable	Not Suitable
Depth (ft)	<0.55	0.55-0.89	0.9-2.1	2.11-2.5	>2.5
Velocity (fps)	<0.15	0.15-0.54	0.55-1.6	1.61-2.2	>2.2

Note: ft = feet; fps = feet per second

ATTACHMENT C

STUDY SITE SPECIFIC RESULTS

This attachment provides the results of the evaluation on a transect-by-transect table. Tables 1C – 5C of the Field Evaluation Forms are provided at the end of this attachment.

DRY CREEK

During the Flow-Habitat Assessment Study, the Panel rated the proportion of the total surface area that provided optimal or suitable habitat for each of the target species/lifestage group in each study reach. These estimates were categorized as follows: <10, 10 to 25, 26 to 40, 41 to 60, 60 to 80, and >80 percent. These estimates reflect the total surface area at a particular flow level and were not adjusted to reflect the change in total surface area that occurred between flows. However, the change in total surface area over the range of flows observed was typically small.

Transect 1

This site included the tail of a pool, a riffle, and the head of a second pool. These features were located among narrow cobble bars with sparse-to- moderate riparian plant cover. Channel gradient was low (not measured). Small gravels and sand dominated substrates within the wetted area. Riprap bank protection occurs along the west bank throughout the reach. Channel incision was noticeable, with steep banks of unconsolidated alluvium along the eastern edges of the active channel; this resulted in an abrupt transition between channel and floodplain. Minimal instream cover was provided by small woody debris, water depth, and surface turbulence. Overhanging riparian vegetation was considered part of the canopy cover, rather than part of instream cover (Table 1C).

This site had some of the best habitat observed for steelhead fry and Chinook salmon juveniles on Dry Creek. The Panel found that habitat for these two lifestages was most abundant at the middle release flow of 90 cfs. At this flow, a fair number of cobbles spread across the broad, even channel bottom provided an abundance of good feeding stations. Habitat decreased markedly at the low and high flows, relative to this flow. At the low and high flows, velocities fell below or above optimum levels, respectively, resulting in a large decrease in the proportional area of optimal and suitable habitat. Habitat for Chinook salmon fry followed a similar pattern, but habitat for juvenile steelhead was most abundant at the highest flow observed. Less than 25 percent of the surface area was considered suitable for coho salmon fry and juveniles at any flow. The high-flow condition appeared to provide the greatest proportion of optimal and suitable habitat for coho salmon fry, while the proportion of optimal and suitable habitat for juvenile coho salmon did not vary with flow.

Transect 2

This site was primarily composed of a shallow, fast riffle. Velocities were high at all three flows evaluated. The channel was mostly shallow; however, at the highest flow (130 cfs), a pool was formed behind the left bank. Channel gradient was low (not measured). Small cobbles dominated the substrate in the wetted channel. Habitat complexity and instream cover were low, particularly at the higher flows.

The habitat available at this location was generally best for juvenile steelhead, which had 40 to 60 percent optimal habitat at the lowest flow observed. Habitat was somewhat less abundant for steelhead fry, and even less abundant for Chinook salmon fry and juveniles. There was little suitable habitat for coho salmon in this area, with the peak of suitable habitat being 10 to 25 percent at the highest flow observed. As flows increased, protected resting areas adjacent to shear zones were obliterated as velocities increased. This resulted in a moderate decrease in habitat for most species and lifestages at the middle flow level. At the highest flow level, habitat was decreased to low levels for most species and lifestages.

Transect 3

This site consisted of a run with a small amount of riffle. The channel was uniform, and the substrate was dominated by medium cobbles. Habitat complexity and instream cover were low at all flows. Velocities were high at all flows, but particularly fast and uniform at the higher flows evaluated. A small amount of lower-velocity habitat was present along the channel margin. Channel gradient was low (not measured).

The habitat at the Transect 3 study area was most suitable for steelhead, providing similar amounts of habitat for juveniles and fry at all flow levels (25 to 40 percent optimal and 40 to 60 percent suitable). The proportion of optimal and suitable habitat for these lifestages gradually declined as flow increased, with the highest flow level providing less than 25 percent suitable habitat and less than 10 percent optimal habitat. Habitat was less abundant for Chinook salmon fry and juveniles, with 10 to 25 percent of the total area being rated as both suitable and optimal at both the low and middle flow levels. At the highest flow, less than 10 percent of the habitat was considered suitable for both lifestages. There was less than 10 percent suitable habitat for coho salmon at any flow level. The highest flow level provided little habitat for any species at this site, while the low flow level provided the greatest proportional area of habitat for steelhead. There was a modest decline in the amount of habitat available at the middle flow level for steelhead, but this flow provided a similar amount and quality of habitat for Chinook salmon.

Transect 4

This site consisted of a riffle. The channel was mostly uniform, and the substrate was dominated by small and medium cobbles. Habitat complexity and instream cover were low at all flows evaluated. Small cobbles dominated the substrate. Velocities were very high at all flows evaluated. Channel gradient was low (not measured).

High velocities prevailed at all flows, and because of this, very little habitat was available for any of the target species. The lowest flow level resulted in 10 to 25 percent of the area being considered optimal habitat, and as much as 25 to 40 percent being considered suitable habitat for juvenile steelhead. This flow also resulted in about 10 to 25 percent of the area being considered suitable for steelhead fry. At the two higher flows less than 10 percent of the habitat was considered suitable for either lifestage of steelhead. Less than 10 percent of the habitat was considered suitable for either Chinook salmon or coho salmon at any flow level.

Transect 5

This site was classified as a pool at the two lower flows evaluated and as a run at the highest flow. Habitat complexity and instream cover were medium at all three flows evaluated. The substrate was dominated by large gravel. The dominant substrate was classified as small-to-medium cobble at the highest flow; however, it is likely that the classifications of “large gravel” made at the lower flows were more accurate, due to greater visibility of the substrate. Embeddedness was fairly high, from 50 percent to greater than 75 percent. Riparian vegetation along both banks extended into the water and contributed to instream cover. This site did not have a dramatic change in velocity as flows increased; depth increased as flows increased. Channel gradient was low (not measured). Channel incision was noticeable, with steep banks of unconsolidated alluvium along both edges of the active channel.

The lowest observed flow provided high proportions of suitable and optimal habitat for Chinook salmon and steelhead fry (40 to 80 percent optimal habitat, and nearly 80 percent suitable habitat). This flow also provided the greatest proportion of suitable and optimal habitat for Chinook salmon juveniles, although a similar amount was available at the intermediate flow level. The intermediate flow level provided the greatest proportion of optimal and suitable habitat for steelhead juveniles and coho salmon fry and juveniles, with only a slight reduction in habitat at the low flow. The high flow at this transect resulted in a reduction in the proportion of available habitat for all species/lifestages. This reduction was large with regard to the optimal habitat of Chinook salmon fry, but modest for all other species/lifestages, where the high flow provided similar amounts of habitat to the low flow, in a few cases. This transect had the most suitable habitat observed for coho salmon in Dry Creek, with up to 40 percent of the area being suitable and 25 percent of the area being optimal at the middle flow level.

Transect 6

This site was primarily considered a run, although at the second flow evaluated (90 cfs) it was determined by many to have both riffle and run characteristics. Habitat complexity ranged from low to medium: “low-plus” at the lowest flow (47 cfs), meaning that it was somewhat better than low, but not quite a medium; medium at the second flow (90 cfs); and low at the third flow (130 cfs). Instream cover was low at all three flows. The dominant substrate was small and medium cobbles, with a few larger cobbles present. The cobbles provided some habitat value, but complexity was lacking. Channel gradient was low (not measured). Channel incision was noticeable, with steep banks of unconsolidated alluvium along both edges of the active channel.

The low flow provided the most abundant habitat for steelhead fry and juveniles of all flow levels, and similar amount to the intermediate flow for Chinook salmon juveniles. At the middle flow level, the proportional area of suitable and optimal habitat was similar to the low flow level for Chinook salmon juveniles, and improved modestly for Chinook salmon fry. The proportion of suitable and optimal steelhead fry habitat at this flow decreased by more than 20 percent. A more modest decrease was noted for steelhead juveniles. Habitat for steelhead fry was among the most abundant seen in Dry Creek, with

60 to 80 percent optimal and suitable for steelhead at the lowest flow. Suitable habitat for coho salmon lifestages was less than 10 percent of the total area at all flows.

Transect 7

This site was characterized as a run at all flows. Habitat complexity was low at all flows, although at the second flow evaluated (90 cfs), complexity was determined to be a "low-plus," or slightly better than "low." Instream cover was low, and consisted of water depth and surface turbulence. The dominant substrate was medium-size gravels. The determination of embeddedness varied, from 25 percent at the first flow (47 cfs) to 50 to 75 percent at the second flow (90 cfs), and "not applicable" at the third flow (130 cfs). Channel gradient was low (not measured). Velocity increased somewhat between the different flow rates, but not as much as at other sites.

The availability of suitable and optimal habitat near the transect 7 site was greatest at the intermediate flow level, when considered across all species/lifestages, although the low flow level provided similar amounts of habitat for most species, and somewhat greater amounts of habitat for steelhead fry. Optimal habitat peaked at 10 to 25 percent at both lifestages of Chinook salmon and juvenile steelhead. For all species, suitable habitat was only slightly more abundant than optimal habitat, and responded to flow in a pattern similar to that of optimal habitat. At intermediate flows, fry and small juveniles were expected to make use of instream cover along stream margins. Such cover consisted of small roots and branches. Little optimal habitat for coho salmon lifestages was available at any flow, and suitable habitat was only slightly more abundant. The amount of suitable habitat for coho salmon was less than 25 percent, while the amount of optimal habitat was less than 10 percent. Intermediate flows provided the greatest proportion of suitable and optimal habitat for both juvenile and fry coho salmon.

Transect 8

This site was characterized as a run at all flows. Habitat complexity was at least a medium at all flows, but at the second flow level (90 cfs), most of the group gave a "medium-plus" rating, while a few members of the group preferred to stay at the "medium" rating. This site had some large woody debris and undercut banks that varied in accessibility for fish at the different flows. These habitat features were a factor in both the habitat complexity and instream cover ratings. Instream cover was rated as "low-plus" at the second flow (90 cfs), but was a "medium" at the other two flows. There was some disparity in ratings of instream cover at the 90 cfs flow: the consensus of the group determined the "low-plus" rating, but some members preferred "low" and some preferred "medium." The substrate was composed of small gravels. Embeddedness was rated 25 to 50 percent at the first flow level, but was determined not to be applicable at the second and third flows because of the small gravel size. Channel gradient was low (not measured).

Transect 8 provided some of the best coho salmon habitat available in Dry Creek. The proportion of suitable habitat for both coho salmon lifestages was greatest at the lowest flow level, with modest decreases in habitat availability at the two higher flow levels. The two higher flow levels had similar proportional availability of juvenile and fry coho salmon habitat. Habitat for Chinook salmon and steelhead lifestages was more available, with 40 to 60 percent of the area considered optimal for Chinook salmon and steelhead juveniles and up to 25 to 60 percent of the area being considered optimal for Chinook salmon and steelhead fry. This high availability of habitat is the result of relatively dense overhanging vegetation that trailed into the water along one bank, combined with a well-developed pool-riffle sequence, which increased availability. Habitat ratings were greatest at the lowest flow level for all species/lifestages, although habitat quality was similar at the middle flow for juvenile steelhead. The amount of habitat at the highest flow was generally reduced relative to the other observed flows.

Transect 9

This site was characterized as a run at all flows. Habitat complexity was low at all flows. Most of the habitat present was too uniform to be preferable for salmonid use. Instream cover was rated "medium" at the first flow (47 cfs), but low at the other two flows evaluated. The substrate was medium gravels. Embeddedness determinations varied from less than 25 percent at 47 cfs to less than 5 percent at 90 cfs and not applicable at 130 cfs. This is likely because of the medium gravel size and the decreased visibility at higher velocities. The channel gradient was low (not measured). This site was a fast, fairly shallow run. The mean velocities were high at all flows, ranging from 2.58 fps to 3.12 fps.

There was little suitable habitat in the vicinity of this transect at any flow for any of the target species/lifestages. The greatest amount of suitable habitat was 10 to 25 percent for juvenile Chinook salmon and fry and juvenile steelhead. This occurred at the lowest flow level for juvenile Chinook salmon and steelhead fry, and was similar at the middle flow level for juvenile steelhead. This area provided less than 10 percent suitable habitat for the other species and lifestages, and at other flow levels.

RUSSIAN RIVER

Coho salmon are thought to use the Russian River primarily as a passage corridor to reach tributary streams where spawning and rearing occur. Therefore, the Panel did not evaluate habitat for coho salmon in this study area.

Transect 1

This site was characterized as a run at all three flows evaluated (Table 3C). The site was located just downstream of a riffle and was the most upstream site on the Agwood property. Habitat complexity was rated low at the 190 cfs flow rate and medium at the 125 cfs and 275 cfs flow rates. Instream cover was low at all flows. The substrate ranged from small gravel to small cobbles, with several larger rocks present, but the dominant substrate was determined to be large gravel. Embeddedness was 5 to 25 percent at the 125 cfs rate, and 25 to 50 percent at the 190 cfs and 275 cfs rates. The channel gradient was low (not measured). Mean velocities ranged from 2.36 fps to 3.80 fps.

At this site, the proportional availability of suitable and optimal habitat was greatest at the lowest flow observed (Table 4C). At this flow, 25 to 40 percent of the total area was rated as suitable for fry of both Chinook salmon and steelhead, while 40 to 60 percent of the total area was rated suitable for juveniles of both species. Optimal habitat at this flow comprised 25 to 40 percent of the area for both lifestages of Chinook salmon and for steelhead fry, and 10 to 25 percent of the area for steelhead juveniles. The proportional availability of habitat generally decreased with increased flow; in most cases by 15 to 30 percent. The exception was optimal habitat for steelhead juveniles, which remained unchanged over all three flows. The greater size and swimming ability of steelhead juveniles allowed them to take advantage of deeper, swifter habitat that became more abundant as flows increased.

Transect 2

This site was characterized as a run at all flows evaluated. It was located on the Agwood property. Habitat complexity was medium at the first two flows evaluated (125 cfs and 190 cfs) and low at the third flow (275 cfs). Instream cover was medium at the first two flows and "low-plus" at the third flow, and mostly consisted of vegetation hanging into the water and depth. The determination of dominant substrate varied, from medium gravel to large gravel to small cobbles. The substrate was largely a mixture of gravels and cobble; thus, the determination of which was dominant varied. Embeddedness was classified as 50 to 75 percent, except at the first flow evaluated, when it was determined as greater than 75 percent. The channel gradient was low (not measured). Mean velocities were not as high as Transect 1, ranging from 1.14 fps to 2.40 fps.

Overall, habitat availability was lower at this site than at Transect 1. Habitat for fry and juvenile lifestages of both target species was greatest at the intermediate flow, which had 10 to 25 percent of the total area classified as optimal, while suitable habitat for juvenile steelhead and salmon ranged as high as 25 to 40 percent rated as suitable. Suitable habitat was present over 25 to 40 percent of the site for steelhead fry and 10 to 25 percent of the area for Chinook salmon fry. Habitat availability decreased modestly at the other two flow levels. This provided approximately equal proportions of suitable and optimal habitat. The higher suitability of habitat at the intermediate flow resulted from the flooding of bank margins, which were too shallow to provide suitable habitat at the low flow.

Transect 3

This site was characterized as a riffle at all three flows, and was located on the Agwood property. Habitat complexity and instream cover were low at all three flows. The dominant substrate was large gravel, and embeddedness was 5 to 25 percent. The channel gradient was low (not measured). The mean velocities ranged from 2.10 fps to 2.75 fps.

Habitat availability was low at this transect, relative to the other transect areas observed on the Russian River. The most abundant suitable habitat (about 10 to 25 percent of the area) for any species/lifestage, occurred at the lowest flow observed. Optimal habitat generally comprised less than 10 percent of the total area. Generally, inadequate depths, high velocities, or the combination of both factors reduced habitat suitability.

Transect 4

This site was classified as a run at all flows evaluated, and was located near the Perkins Street bridge. Habitat complexity and instream cover were low at all three flows. The dominant substrate varied from small to medium gravel. Embeddedness determinations varied from 50 to 75 percent to greater than 75 percent and “not applicable.” This determination likely varied because of the small/medium gravel size and the difficulty in determining embeddedness with small substrate particles. Channel gradient was low (not measured). The mean velocities ranged from 1.61 fps to 2.82 fps.

Habitat availability varied with flow, and the pattern of increase/decrease was inconsistent from species to species at this transect. Availability of suitable habitat was more stable across the range of flows than availability of optimal habitat. Suitable habitat was relatively plentiful for both lifestages of Chinook salmon at this transect during low flows. However the availability of optimal habitat was much less, indicating that habitat quality was fairly low for these species. Habitat decreased for Chinook salmon fry as flows decreased, while the intermediate flow provided the best habitat for juvenile Chinook salmon. Habitat for steelhead was not as abundant as for Chinook salmon. Steelhead fry habitat declined with flow. At the lowest flow, 25 to 40 percent of the total area was considered suitable, and less than 10 percent was considered optimal. Steelhead juvenile habitat increased with flow. At the highest flow level, 25 to 40 percent of the area was considered suitable and 10 to 25 percent of the area was considered optimal.

Transect 5

This site was classified as a riffle at all flows, and was located near the Perkins Street bridge. Habitat complexity was high at the first flow (125 cfs), medium at the second flow (190 cfs), and “medium-plus” at the third flow (275 cfs). The important habitat complexity and instream cover components included variations in velocity, vegetation along (and within) the channel margins, and the variety of substrate materials. The dominant substrate determination ranged from medium gravel to small cobble; a mixture of these various sizes was present. Embeddedness was low, rated 5 to 25 percent. Channel gradient was low (not measured). The mean velocities ranged from 1.76 to 2.73.

Optimal habitat for all target species/lifestages was moderately abundant, with 25 to 40 percent of the area being considered optimal for both lifestages of both species during the low flow release. Relative to other areas of the river that were observed, the availability of suitable and optimal habitat at Transect 5 was high for fry of both species. Similar levels of habitat were observed for steelhead juveniles as well, although habitat for this species/lifestage was present at similar levels in other portions of the river. Habitat was of uniformly high quality, as most of the suitable habitat was also characterized as being optimal. As discharges climbed, habitat became less abundant because of rising velocities. Rising flows reached onto gradually sloping gravel bars along banks and surrounding mid-channel bars. This served to moderate loss of habitat, as the low–velocity areas favored by early lifestages continued to be available, although not in the same location in the channel.

Transect 6

This site was characterized as a riffle at all three flows, and was located on the Rudick property. Habitat complexity and instream cover were low at all flows. The dominant substrate determination varied from medium gravel to small cobbles. Embeddedness determinations varied from 25 to 50 percent to 50 to 75 percent. The channel gradient was low (not measured). Mean velocities were low compared to the other sites, ranging from 1.01 fps to 1.49 fps.

Very little habitat was available in this relatively homogeneous, and shallow riffle for any species/lifestage at any flow level. This resulted from a channel that was low in complexity and small substrate sizes that were insufficient to provide substantial holding habitat for target species. The amount and quality of habitat did not vary significantly as flows changed, although a slightly higher percentage of suitable habitat was present for Chinook salmon and steelhead fry and steelhead juveniles at the lowest flow observed. Less than 10 percent of the area was considered optimal habitat for any species/lifestage at any flow.

Transect 7

This site was characterized as a run at all flows evaluated, and was located on the Rudick property. Habitat complexity and instream cover were low at all flows. An undercut bank provided habitat, but not enough to raise the instream cover rating to a medium. The substrate was uniform, composed mostly of sand and small gravels. Embeddedness was determined not to be applicable because of the small substrate size. Channel gradient was low (not measured). Mean velocities ranged from 1.56 fps to 1.85 fps.

In contrast to all other study sites, suitable habitat availability was observed to be greatest at the highest flow for juvenile Chinook salmon and steelhead. However, due to a lack of cover elements, much of this habitat was judged to be suitable (40 to 60 percent), but not optimal (<10 percent). Optimal habitat for juvenile Chinook salmon and steelhead comprised 10 to 25 percent of the total area at the intermediate flow, but less than 10 percent at the high flow. At the intermediate discharge, deeper water along undercut banks with overhanging vegetation provided a combination of protected resting areas next to shear zones affording good feeding opportunities for fish. At the high discharge, velocities in the resting areas were increased to unsuitable levels. The lowest flow provided the greatest proportion (10 to 25 percent) of suitable and optimal habitat for steelhead fry.

Transect 8

This site was classified as a run at all flows evaluated, and was located on the Fetzer property. Habitat complexity was rated low to "low-plus." The substrate was mostly sand and uniform. Small areas of cover occurred under the overhanging vegetation, but velocities tended to be high in those areas. Instream cover was rated from low to medium, largely due to the overhanging vegetation that extended into the water. Embeddedness was not applicable because of the sandy substrate. Channel gradient was low (not measured). The channel was fairly incised, with steep banks on both sides of the channel. Velocities at the site were quite high, with mean velocities ranging from 3.27 fps to 3.64 fps. Depth increased with the higher flows, but the velocity was high throughout the study.

At the low and intermediate flows, modest amounts of habitat were available to juvenile Chinook salmon and steelhead. For both species, both optimal and suitable habitat comprised 10 to 25 percent of the total area at these flows. Suitable habitat was somewhat greater for the fry lifestage of both species, with 25 to 40 percent of the area considered to be suitable. The proportion of optimal habitat for fry of both species was 10 to 25 percent, at the lowest flow. For fry, the lowest flow provided the greatest proportional area of habitat, while for juveniles the low and intermediate flows provided the same amount and quality of habitat. Higher quality habitat for juveniles was provided by a combination of slow and deep water, with overhead cover, and nearby feeding opportunities at the downstream edge of riffle habitat. Habitat availability for all species/lifestages decreased at the highest flow.

Transect 9

This site was characterized as a riffle at all flows, and was located on the Fetzer property. Habitat complexity ranged from medium to "medium-plus." Instream cover ranged from "low-plus" to "medium-minus." The important components of habitat complexity and instream cover included overhanging riparian vegetation and variation in velocity in the channel. The dominant substrate was medium gravel. Embeddedness was low, from 5 to 25 percent at the first flow to 25 to 50 percent at the second and third flows. Channel gradient was low (not measured), but incision was fairly high, with steep banks on both sides of the channel. Mean velocities ranged from 1.55 fps to 2.81 fps.

In the Transect 9 site, habitat availability was greatest at the lowest flow for all species/lifestages, when optimal and suitable habitat are considered in tandem. For Chinook salmon and steelhead fry, the intermediate flow provided a similar amount of optimal habitat, but less suitable habitat. Habitat decreased moderately with increasing flow for both Chinook salmon lifestages and for steelhead fry. Habitat decreased substantially for steelhead juveniles between the low and intermediate flow. At the lowest flow observed, half or more of the area in this study site was rated as suitable for juvenile steelhead, while 25 to 40 percent of the site was rated as optimal habitat for this species/lifestage. At that same discharge, optimal habitat for Chinook salmon juveniles comprised 10 to 25 percent of the area. Although velocities varied across the channel, habitat conditions favored the larger (and faster swimming) steelhead juveniles over the smaller Chinook salmon juveniles.

Transect 10

This site was located near Commisky Station, and was characterized as a run/riffle at the first flow, a riffle at the second flow, and a run at the third flow. Part of the variation in determinations was due to having two distinct channels with somewhat different characteristics. At the higher flow evaluated, both sides were functioning as a run. Habitat complexity was high at the first two flows and "high-minus" at the third flow. Instream cover varied from "high-minus" at the first flow, high at the second flow, and medium at the third flow. The substrate was composed of a variety of particle sizes, from smaller gravel/fine substrate to large boulders. The dominant size was primarily large gravel, but there were many other sizes present. Embeddedness was 5 to 25 percent at the first two flows, and 25 to 50 percent at the third flow. The channel gradient was low (not measured). Mean velocities ranged from 2.06 fps to 2.60 fps.

At Transect 10 and at the adjacent site (Transect 11), the proportion of suitable and optimal habitat were among the highest observed on the Russian River. At the lowest flow, the proportion of the area rated as optimal by the panel was 40 to 60 percent for steelhead and Chinook salmon juveniles. This same proportion was considered suitable for Chinook salmon juveniles, while 60 to 80 percent of the area was considered suitable for steelhead juveniles. A smaller proportion of the area (25 to 40 percent) was considered suitable for fry of both species. Optimal habitat comprised 25 to 40 percent of the area for steelhead fry and 10 to 25 percent of the area for Chinook salmon fry. For all species and lifestages, the proportion of habitat considered suitable and optimal decreased moderately at the intermediate flow, and substantially at the highest flow observed. However, water temperatures in this reach are thought to regularly exceed the optimal range for Chinook salmon and steelhead, although they remain suitable. During the warmer months, the benefits provided by increased channel complexity and the abundance of cover are moderately reduced by sub-optimal temperatures.

Transect 11

This site was classified as a riffle at all flows, and was located near Commisky Station. Habitat complexity ranged from “medium-plus” to high, and was highest at the lowest flow evaluated (125 cfs). Instream cover ranged from “low-plus” to “medium-minus,” and was highest at the second flow evaluated (190 cfs). The substrate was composed of a variety of particle sizes, from smaller gravel/fine substrate to large boulders. The most prevalent size was large gravel. Embeddedness was 5 to 25 percent at the first and third flows, and 25 to 50 percent at the second flow. Channel gradient was low (not measured). Mean velocities ranged from 2.34 to 2.95. Depth was fairly high in some parts of this site (including a deep pool with large boulders), relative to other sites.

Habitat availability ratings at this transect are similar to those for Transect 10. Habitat availability was among the highest observed on the Russian River, with the lowest flows providing the greatest amount of habitat, and habitat decreasing modestly at the intermediate flow and substantially at the highest flow. As with Transect 10, the value of this habitat is somewhat reduced by less than optimal temperatures in the summer months. During late winter and spring periods, the high diversity of habitat at this transect likely benefits larger juveniles as they move downstream and prepare to undergo smoltification.

Transect 12

This site was characterized as a riffle at all flows, and was located near the Cloverdale Bridge. Habitat complexity was low at all flows. Instream complexity was low at the first and third flows, but was rated “lowplus” at the second flow, largely because of the presence of some deeper pools and larger cobbles, which provided some cover and variability in habitat. The substrate was composed of a variety of sizes of rocks, including medium gravel, large gravel, and small to large cobble. Embeddedness determinations varied from 25 to 50 percent to 50 to 75 percent, likely because of the variability of rock sizes. Channel gradient was low (not measured). Mean velocities were low compared to other sites, from 1.20 fps to 2.36 fps. This is probably because of the decrease in flow rate between Site 1 and Site 12.

At this site, the proportional area of habitat was greatest at low flows, for all species/lifestages. A similar proportion of habitat for juvenile steelhead was available at the intermediate flow. Habitat decreased moderately with increasing flow. The panel found that 25 to 40 percent of the area provided suitable habitat for fry of both species at the lowest flow. Optimal habitat made up 10 to 25 percent of the area at this flow. For juveniles of both species, the corresponding percentages were 10 to 25 suitable and less than 10 optimal. At the highest flow, less than 10 percent of the habitat was considered suitable for any species/lifestage. Water temperatures during warm months are likely sub-optimal for salmonids.

Transect 13

This site was characterized as a run at all three flows, and was located near the Cloverdale Bridge. Habitat complexity varied from "low-plus" to medium. Although the site did not appear to have good salmonid habitat characteristics, there was a diverse range of rock sizes and diversity in velocities that would provide important habitat. Instream cover was rated "low-plus" for the same reasons. Because of the variability of rock sizes in the substrate, it was difficult to determine one dominant substrate size; particles ranged from medium gravel to small cobbles. Embeddedness ranged from 25 to 50 percent at the second and third flows to greater than 75 percent at the first flow. Channel gradient was low (not measured). Mean velocities ranged from 0.68 fps to 1.26 fps.

At this site, the highest proportional availability of both suitable and optimal habitat occurred at the lowest flow level observed for all species/lifestages. The availability of suitable habitat decreased at the intermediate flow level for all species/lifestages, except steelhead juveniles, where it remained the same. At the highest flows, the availability of suitable habitat similar to what was available at the middle flow for all species/lifestages, except juvenile Chinook salmon, where suitable habitat continued to decrease. The proportional availability of optimal habitat at the high flow (relative to the middle flow) increased moderately for Chinook salmon fry, remained the same for Chinook salmon juveniles and steelhead fry, and decreased moderately for juvenile steelhead.

The proportional availability of suitable habitat at the low flow was 40 to 60 percent for juvenile Chinook salmon and 25 to 40 percent for the other species/lifestages. The proportional availability of optimal habitat at this flow was 25 to 40 percent for both lifestages of Chinook salmon and 10 to 25 percent for both lifestages of steelhead. At the highest flow level, suitable and optimal habitat was reduced to 10 to 25 percent and for all species/lifestages, except juvenile steelhead, for which 25 to 40 percent of the total area was rated suitable and less than 10 percent was rated optimal. Water temperatures during warm months are likely sub-optimal for salmonids. Habitat available in cooler months, when water temperatures are acceptable, would benefit pre-smolts traversing this section of the river.

Dry Creek Flow Assessment Study

Table 1C. Habitat Characteristics Observed at Dry Creek Study Sites.

	Flow	1	2	3	4	5	6	7	8	9
Habitat Type	47	Pool	Riffle	Run	Riffle	Pool	Run	Run	Run	Run
Habitat Complexity (L, M, H)		Low	Med	Low	Low	Med	Low+	Low	Med	Low
Dominant Substrate*		4	4	4/5	4/5	3	4 - 5	2	1	2
Embeddedness (%)**		25 - 50	25	<25	<5	50 - 75	<25[1]	25	25 - 50	<25
Instream Cover (Low, Med, High)		Low	Med	Low	Low	Med	Low+	Low	Med	M
Habitat Type	90	Run	Riffle	Run	Riffle	Pool	Riffle	Run	Run	Run
Habitat Complexity (Low, Med, High)		Low+	Med	Low	Low	Med	Med	Low+	Med+[4]	Low
Dominant Substrate*		4	4[2]	4	4	3	4	2	1	2
Embeddedness (%)**		25 - 50	5 - 25	5 - 25	5 - 25	>75	5 - 25	50 - 75[3]	[3]	<5
Instream Cover (Low, Med, High)		Low	Low	Low	Low	Med	Low	Low+	Low+[5]	Low
Habitat Type	130	Run	Riffle	Run	Riffle	Run	Run	Run	Run	Run
Habitat Complexity (Low, Med, High)		Low	Med[6]	Low	Low	Med	Low	Low	Med	Low
Dominant Substrate*		4	4	4	4	4/5	4/5	2	1	2
Embeddedness (%)**		25 - 50	5 - 25	5 - 25	5 - 25	25 - 50	5 - 25	n/a	n/a	n/a
Instream Cover (Low, Med, High)		Low	Low	Low	Low	Med	Low	Low	Med	Low

* **Substrate: 0** Fines<4mm, **1** Sm. Gravel 4-25mm, **2** Med. Gravel 26-50mm, **3** Lg. Gravel 51-75mm, **4** Sm. Cobble 76-150mm, **5** Med. Cobble 151-225mm, **6** Lg. Cobble 226-300mm, **7** Sm. Boulder 301-600mm, **8** Lg. Boulder>600mm, **9** Bedrock

** **Embeddedness: <5, 5-25, 25-50, 50-75, >75**

[1] TD - 25 - 50

[2] High end of range

[3] Embeddedness not as relevant with gravel substrate

[4] BH/BC/SL - rate as Med

[5] BC - Low; SL - Med

[6] BH - Med-

Table 2C. Percent of Optimal and Suitable Habitat Observed at Dry Creek Study Sites

		Flow	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]	7[g]	8[h]	9[i]
Chinook Fry	Suitable	47	40 - 60	10 - 25	10 - 25	<10	>80	10 - 25	10 - 25	40 - 60	<10
		90	40 - 60 [10]	10 - 25 [11]	10 - 25	<10	40 - 60 [10]	25 - 40 [17]	10 - 25 [10]	40 - 60	<10
		130	25 - 40 [21]	10 - 25	<10	<10	25 - 40	10 - 25	<10	10 - 25	<10
	Optimal	47	25 - 40	<10	<10	<10	60 - 80	10 - 25	<10	25 - 40	<10
		90	25 - 40 [10]	>10	<10	<10	40 - 60	10 - 25	10 - 25 [11]	10 - 25	<10
		130	<10	<10	<10	<10	<10	<10	<10	10 - 25	<10
Chinook Juvenile	Suitable	47	25 - 40	10 - 25	10 - 25	<10	40 - 60 [4]	25 - 40	10 - 25	40 - 60	10 - 25
		90	>80 [12]	10 - 25 [11]	10 - 25	<10	40 - 60	25 - 40 [16]	25 - 40	40 - 60	<10
		130	25 - 40	<10	<10	<10	25 - 40	<10	10 - 25	10 - 25	<10
	Optimal	47	<10	<10	10 - 25	<10	25 - 40	10 - 25	<10	40 - 60	<10
		90	60 - 80 [13]	>10	10 - 25	<10	25 - 40	10 - 25	10 - 25 [18]	10 - 25	<10
		130	10 - 25	<10	<10	<10	10 - 25	<10	<10	10 - 25	<10
		Flow	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]	7[g]	8[h]	9[i]
Coho Fry	Suitable	47	10 - 25	<10	<10	<10	10 - 25	<10	10 - 25	25 - 40	<10
		90	<10 [14]	>10	<10	<10	25 - 40	<10	10 - 25 [19]	10 - 25	<10
		130	10 - 25	10 - 25 [22]	<10	<10	10 - 25 [11]	<10	<10	10 - 25	<10
	Optimal	47	<10	<10	<10	<10	10 - 25	<10 [25]	<10	10 - 25	<10
		90	<10	>10	<10 [11]	<10	10 - 25	<10	<10	<10	<10
		130	10 - 25	<10	<10	<10	<10	<10	<10	<10	<10
Coho Juvenile	Suitable	47	10 - 25	10 - 25	<10	<10	10 - 25 [5]	<10	<10	25 - 40	<10
		90	10 - 25	>10	<10 [11]	<10	25 - 40	<10	10 - 25	<10	<10
		130	10 - 25	<10	<10	<10	10 - 25	<10	<10	<10	<10
	Optimal	47	<10	<10	<10	<10	>10 [5]	<10	<10	10 - 25	<10
		90	<10	>10	<10	<10	10 - 25	<10	<10	<10	<10
		130	<10	<10	<10	<10	<10	<10	<10	<10	<10
		Flow	1[a]	2[b]	3[c]	4[d]	5[e]	6[f]	7[g]	8[h]	9[i]
Steelhead Fry	Suitable	47	60 - 80	25 - 40	40 - 60	10 - 25	<80	60 - 80	25 - 40	60 - 80	10 - 25
		90	60 - 80	10 - 25	25 - 40 [10]	<10	10 - 25	25 - 40	10 - 25	40 - 60	<10
		130	60 - 80 [11]	10 - 25	<10	<10	10 - 25	10 - 25	<10	10 - 25	<10
	Optimal	47	10 - 25	10 - 25	25 - 40 [2]	<10	40 - 60 [6]	60 - 80	10 - 25 [7]	40 - 60	<10
		90	60 - 80	>10	10 - 25 [10]	<10	10 - 25	10 - 25	10 - 25 [11]	10 - 25	<10
		130	25 - 40	<10	<10	<10	<10 [23]	<10	<10	10 - 25 [24]	<10
Steelhead Juvenile	Suitable	47	10 - 25	40 - 60 [1]	40 - 60	25 - 40 [2]	40 - 60	40 - 60	10 - 25	40 - 60 [9]	10 - 25
		90	25 - 40	25 - 40 [10]	25 - 40 [11]	<10	40 - 60	25 - 40	10 - 25	40 - 60	10 - 25
		130	40 - 60	10 - 25	10 - 25	<10	25 - 40	<10	10 - 25	25 - 40	<10
	Optimal	47	<10	40 - 60	25 - 40	10 - 25 [3]	10 - 25	25 - 40	<10	25 - 40 [8]	<10
		90	10 - 25	10 - 25	10 - 25 [11]	<10	25 - 40	10 - 25 [8,15]	10 - 25	25 - 40 [20]	<10
		130	10 - 25	<10 [10]	<10	<10	10 - 25 [26]	<10	<10	10 - 25	<10

a Canopy provides little shade; lacks complexity needed to be optimal for coho
b Velocities/depths inappropriate for chinook; good complexity for steelhead esp. on left bank
c Low habitat complexity
d Better for juvenilles than fry; steelhead scores at low end of ranges - velocities too great
e Juvenilles - low food availability = good not excellent; fry - velocities too great
f Complexity lacking, no large rocks for velocity refuge
g Flow 47: Insufficient cover - low complexity, substrate too small
Flow 90: Better for chinook vs steelhead juveniles - smaller average size = better
h Flow 47: Great habitat: high food availability, abundant cover
i Fast shallow run - velocities too great, channel structure too uniform

1 BC - 75%
2 TD - 10 - 25%
3 TD - <10%
4 SL - High end of range
5 RF - Low end of range
6 TD - 60-80%
7 BC - <10%
8 RF - One category lower
9 SW - High end of range
10 High end of range
11 Low end of range
12 AH - 60 - 80%
13 BC - >80%
14 BH - low end of range
15 BH - low end of range
16 AH - 10-25%
17 PL/BH - low end of range
18 Low habitat complexity
19 Cover provided by overhanging branches, deep water
20 Poor substrates,caliber too small
21 SW - low end of range
22 BH/SW/AH - <10%
23 too deep for higher score
24 BH/TD - <10%
25 BC - <<10%
26 no structure

Table 3C. Habitat characteristics at Russian River Transects.

	Flow	1	2	3	4	5	6	7	8	9	10	11	12	13
Habitat Type	125	Run	Run	Riffle	Run	Riffle	Riffle	Run	Run	Riffle	Run/Riffle	Riffle	Riffle	Run
Habitat Complexity (Low, Med, High)		M	M[5]	L	L	H	L	L	L+	M	H	H	L	M[13]
Dominant Substrate[1]		3[4]	4[6]	3	1[7]	4	4	1	2[9]	2	3[10]	Mix[12]	3	3
Embeddedness[2]		5 - 25[3]	775	5 - 25	>75	5 - 25	25 - 50	n/a	775	5 - 25	5 - 25	5 - 25	50 - 75	775
Instream Cover (Low, Med, High)		L	M	L	L	M	L	L[8]	M	M-	H-[11]		L	L+[14]
Habitat Type	190	Run	Run	Riffle	Run	Riffle	Riffle	Run	Run	Riffle	Riffle	Riffle	Riffle	Run
Habitat Complexity (Low, Med, High)		L	M	L	L	M	L	L	L	M	H	H/M[17]	L	M
Dominant Substrate[1]		3	2	3	1	4/2[15]	3	1	2	2	Mix[12]	3	4	4
Embeddedness[2]		25 - 50	50 - 75	5 - 25	n/a	5 - 25	25 - 50	n/a	50 - 75	25 - 50	5 - 25	25 - 50	25 - 50	25 - 50
Instream Cover (Low, Med, High)		L	M	L	L	M-	L	L	L	M-	H	M-	L+	L+[16]
Habitat Type	275	Run	Run	Riffle	Run	Riffle	Riffle	Run	Run	Run	Run	Riffle[19]	Riffle	Run
Habitat Complexity (Low, Med, High)		M	L+	L	L	M+	L	L	L+	M -	H-	M+	L	L+
Dominant Substrate[1]		3	3	3	2	3	2	1	2	2	3	Mix[12]	Mix[12]	4/2
Embeddedness[2]		25 - 50	50 - 75	5 - 25	50 - 75	5 - 25	50 - 75	n/a	n/a	25 - 50	25 - 50	5 - 25	25 - 50	25 - 50
Instream Cover (Low, Med, High)		L	L+	L	L	M	L	L	L+	L+	M	L+[18]	L	L+[20]

[1] **Substrate: 0** Fines<4mm, **1** Sm. Gravel 4-25mm, **2** Med. Gravel 26-50mm, **3** Lg. Gravel 51-75mm, **4** Sm. Cobble 76-150mm, **5** Med. Cobble 151-225mm, **6** Lg. Cobble 226-300mm, **7** Sm. Boulder 301-600mm, **8** Lg. Boulder>600mm, **9** Bedrock

[2] **Embeddedness: <5, 5-25, 25-50, 50-75, >75**

[3] some areas with less than 5% embeddedness, some with more than 25%

[5] BC rates H-

[6] substrate is a mixture of gravel and cobble

[7] between 1 and 2

[8] nice undercut bank, but not a large enough component to rate Med

[9] BH/TT argue for score of 1

[10] some large boulders present, some smaller rocks/fines, dominant size is a 3

[11] much more diversity than other sites - velocity, rocks, logs

[12] Mixture with equal parts 1,2,4,6

[13] Some larger rocks and small areas with diverse velocity fields

[14] improved by small boulders in substrate

[15] co-dominant

[16] small boulders in substrate

[17] extended deliberation prior to agreement

[18] some deeper pools, a few small boulders

[19] deep pool with very large boulders

[20] small boulders present, not plentiful

Table 4C. Percent of Optimal and Suitable Rearing Habitat at Russian River Transects

		Flow	1	2[a]	3	4	5	6	7	8	9	10	11	12	13
Chinook Fry	Suitable	125	25 - 40[1]	10 - 25[2]	<10	60 - 80	40 - 60	10 - 25[7]	25 - 40[8]	25 - 40	25 - 40	25 - 40[1, 7, 10]	25 - 40	25 - 40	25 - 40
		190	10 - 25[2]	10 - 25	<10	25 - 40	10 - 25	<10	<10	10 - 25	10 - 25	10 - 25	<10	10 - 25	10 - 25
		275	<10	<10	<10	10 - 25	10 - 25	<10[19]	40 - 60[21]	10 - 25[22]	10 - 25	<10[23,24]	<10	<10[25]	10 - 25[26]
	Optimal	125	25 - 40[2]	<10	<10	10 - 25	25 - 40[1]	<10	<10	10 - 25	10 - 25	10 - 25[1]	10 - 25	10 - 25[14]	25 - 40
		190	<10	10 - 25	<10	<10	10 - 25	<10	<10	<10	10 - 25	10 - 25	<10	<10	<10
		275	<10	<10	<10	<10	10 - 25	<10[19]	<10[21]	<10[22]	<10	<10[23,24]	<10	<10[25]	10 - 25[2, 26]
Chinook Juvenile	Suitable	125	40 - 60[1]	10 - 25	10 - 25	40 - 60	25 - 40[1]	<10	10 - 25[9]	10 - 25[1]	10 - 25	40 - 60	25 - 40	10 - 25	40 - 60
		190	10 - 25[1]	25 - 40	<10	40 - 60	10 - 25	<10	10 - 25	10 - 25	<10	10 - 25	10 - 25	<10	25 - 40[15]
		275	10 - 25	<10	<10	25 - 40	10 - 25	<10[19]	40 - 60[21]	10 - 25[22]	<10	10 - 25[23,24]	<10	<10[25]	10 - 25[26]
	Optimal	125	25 - 40[2]	10 - 25	<10	<10	25 - 40[2]	<10	<10	10 - 25[2]	10 - 25	40 - 60[11]	25 - 40	<10	25 - 40
		190	10 - 25[2]	10 - 25	<10	10 - 25	10 - 25	<10	10 - 25	10 - 25	<10	10 - 25	<10	<10	10 - 25
		275	<10	<10	<10	10 - 25	10 - 25	<10[19]	<10[21]	<10[22]	<10	<10[23,24]	<10	<10[25]	10 - 25[1, 26]
Steelhead Fry	Suitable	125	25 - 40[1]	<10	10 - 25	25 - 40	40 - 60	10 - 25	10 - 25	25 - 40	25 - 40	25 - 40	25 - 40	25 - 40[2]	25 - 40
		190	10 - 25	10 - 25	<10	10 - 25[1a]	25 - 40[2]	<10	<10	10 - 25	10 - 25	10 - 25	<10	10 - 25	10 - 25
		275	<10	<10	<10	10 - 25	10 - 25[17]	<10[20]	40 - 60	10 - 25	10 - 25	<10	<10	<10	10 - 25
	Optimal	125	25 - 40[2]	<10	10 - 25	<10	25 - 40	<10	10 - 25	10 - 25	10 - 25	25 - 40	25 - 40[2]	10 - 25	10 - 25
		190	<10	10 - 25	<10	<10	10 - 25	<10	<10	<10	10 - 25	10 - 25	<10	<10	10 - 25
		275	<10	<10	<10	<10	<10[18]	<10[20]	<10	<10	<10	<10	<10	<10	10 - 25
Steelhead Juvenile	Suitable	125	40 - 60	10 - 25	10 - 25[4]	10 - 25[2]	40 - 60[2, 6]	10 - 25	10 - 25	10 - 25	40 - 60	60 - 80	60 - 80[12]	10 - 25	25 - 40
		190	25 - 40	25 - 40	<10	10 - 25	25 - 40[1]	<10	10 - 25	10 - 25	<10	25 - 40[1]	25 - 40	10 - 25	25 - 40
		275	10 - 25	10 - 25[1]	10 - 25	25 - 40[16]	10 - 25	<10[20]	40 - 60	10 - 25	<10	10 - 25	10 - 25	<10	25 - 40
	Optimal	125	10 - 25[3]	<10	<10[5]	<10	25 - 40	<10	<10	10 - 25	25 - 40	40 - 60	40 - 60[13]	<10	10 - 25
		190	10 - 25	10 - 25	<10	<10	10 - 25	<10	10 - 25	10 - 25	<10	25 - 40[2]	10 - 25	<10	10 - 25
		275	10 - 25	<10	<10	10 - 25[16]	10 - 25	<10[20]	<10	<10	<10	<10	<10	<10	10 - 25

Category: <10, 10-25, 25-40, 40-60, 60-80, >80

[a] Flow 125 cfs: good cyprinid habitat
[1] high end of range
[1a] probably high end of range
[2] low end of range
[3] Habitat favorable
[4] SL 10 - 25%, BC 25 - 40%, BH < 10%
[5] SW/SL <10%, BC 10 - 25%, BH <10%
[6] BH/SW/TD 60 - 80%; 25 - 40% optimal
[7] excessive velocity
[8] good depth and velocity, unfavorable substrate complexity
[9] poor substrate, uniform sand, juvenilles likely only beneath undercut bank
[10] good habitat
[11] high end of 40 - 60% suitable;low end of 40 - 60% optimal
[12] BH 40 - 60%
[13] SW 40 - 60% for both suitable and optimal
[14] BH/SW <10%
[15] TD/RF next lower category for suitable
[16] velocities too low across most of channel
[17] Substrate conditions improved by presence of small boulders
[18] near 10%
[19] small area of slower velocity along edge affords good habitat; still <10%
[20] very high velocities, poor substrate
[21] severe lack of cover; sandy substrate; low complexity; poor habitat
[22] high velocities; poor substrate; limited cover
[23] extended deliberation: <10% vs 10 - 25%
[24] extended deliberation: <10% vs 10-25%
[25] favorable substrates due to small boulders, but velocity much too high
[26] favorable complexity, velocities - overall quality limited

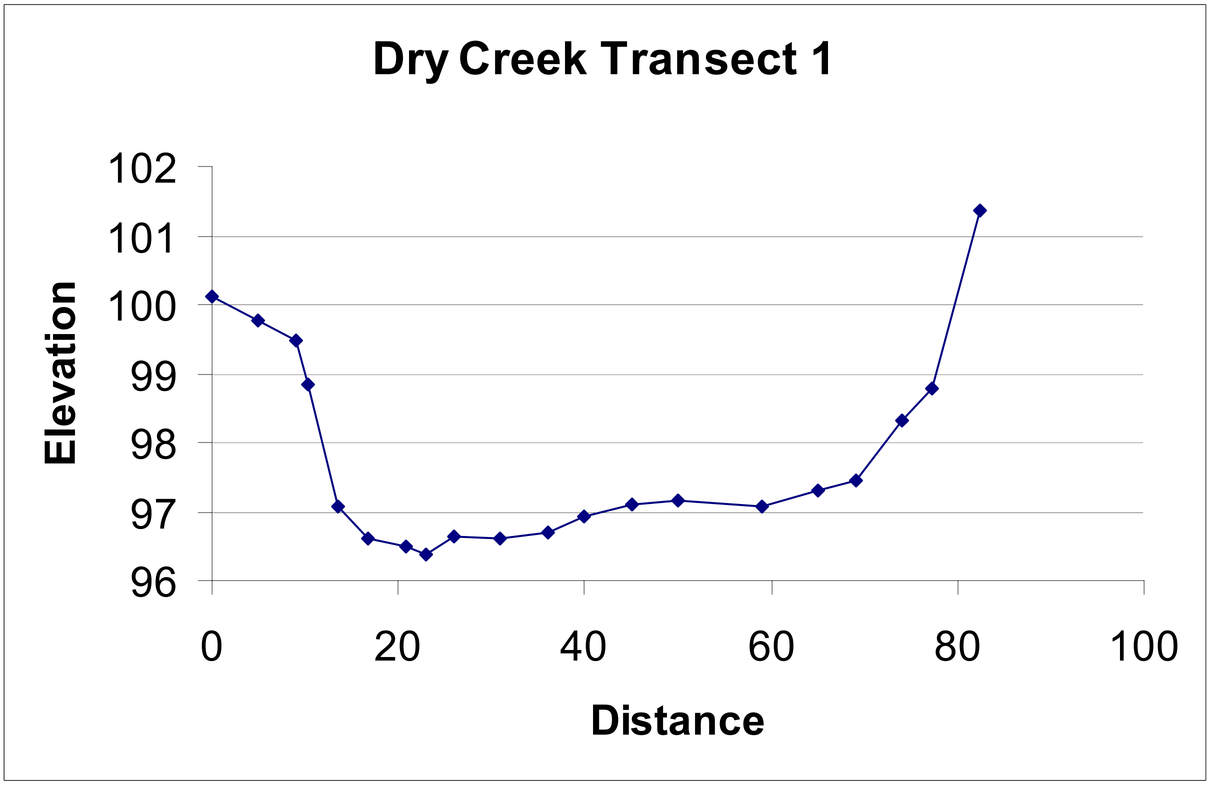
Table 5C. Percent of optimal and suitable habitat spawning by species for Russian River transects at each flow level.

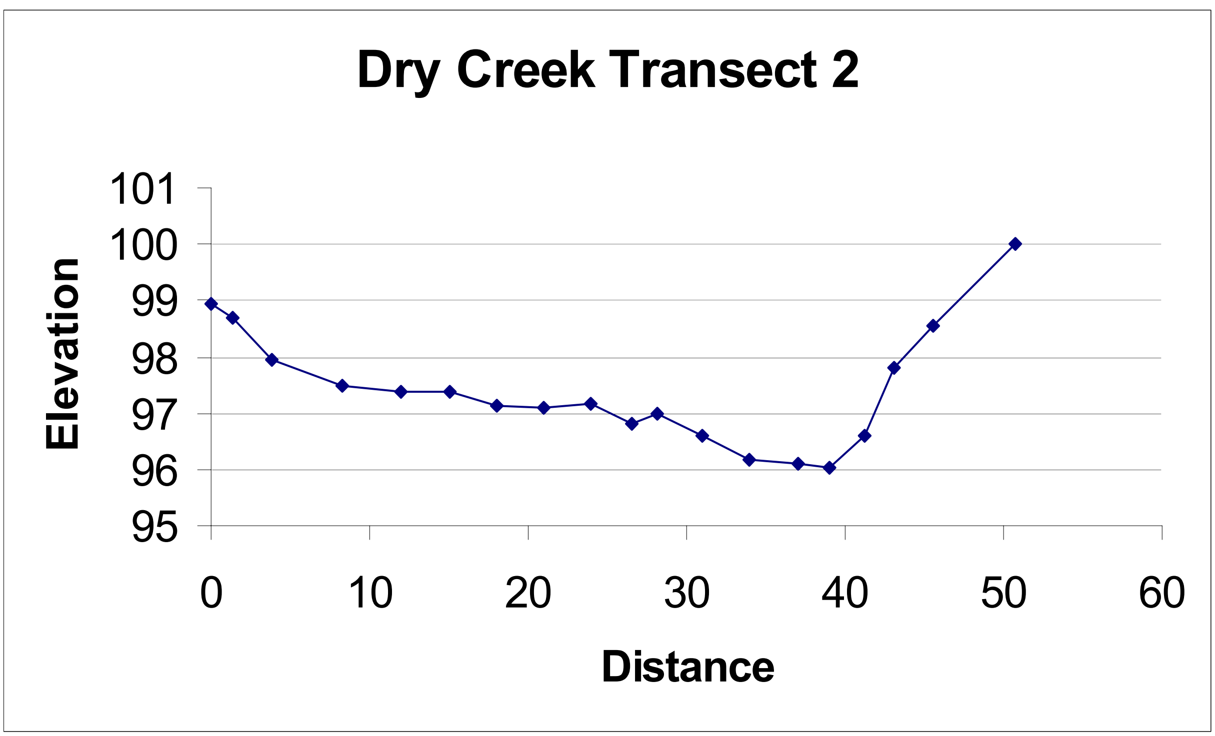
		Flow	1	2	3	4	5	6	7	8	9	10	11	12	13
Chinook Spawners	Suitable	125	10 - 25[2,3]	0	25 - 40[2,4]	0	25 - 40[1,5]	10 - 25[7]	<10	0	<10	<10[8]	10 - 25	<10	0
		190	10 - 25	<10	40 - 60	0	40 - 60	25 - 40	<10	0	<10	10 - 25	<10	10 - 25	<10[10]
		275	10 - 25	0	40 - 60	0	25 - 40[2]	10 - 25	0[12]	0[12]	0	<10[13]	10 - 25	10 - 25[14]	<10
	Optimal	125	<10	0	10 - 25[2]	0	10 - 25[1]	<10	0	0	0	<10[8]	<10	<10	0
		190	<10	0	10 - 25	0	25 - 40	10 - 25	0	0	<10	10 - 25	<10	10 - 25	0
		275	<10	0	25 - 40[2]	0	10 - 25	<10[11]	0[12]	0[12]	0	0	<10	<10[14]	0[15]
		Flow	1	2	3	4	5	6	7	8	9	10	11	12	13
Steelhead Spawners	Suitable	125	10 - 25[1]	0	25 - 40[1]	-	40 - 60[6]	40 - 60	<10	<10	<10	10 - 25	10 - 25	10 - 25	<10
		190	25 - 40[2]	<10	40 - 60	0	40 - 60	40 - 60	<10	0	10 - 25	10 - 25	<10	10 - 25	<10
		275	10 - 25	0	40 - 60	0	25 - 40	10 - 25	0	0	<10	<10	10 - 25	10 - 25	<10
	Optimal	125	10 - 25[2]	0	10 - 25[1]	-	40 - 60[6]	10 - 25	0	0	0	<10	10 - 25	<10	0
		190	10 - 25[2]	0	10 - 25	0	25 - 40	10 - 25	0	0	<10	10 - 25[9]	<10	10 - 25	0
		275	10 - 25	0	10 - 25	0	10 - 25	<10	0	0	0	0	<10	<10	0

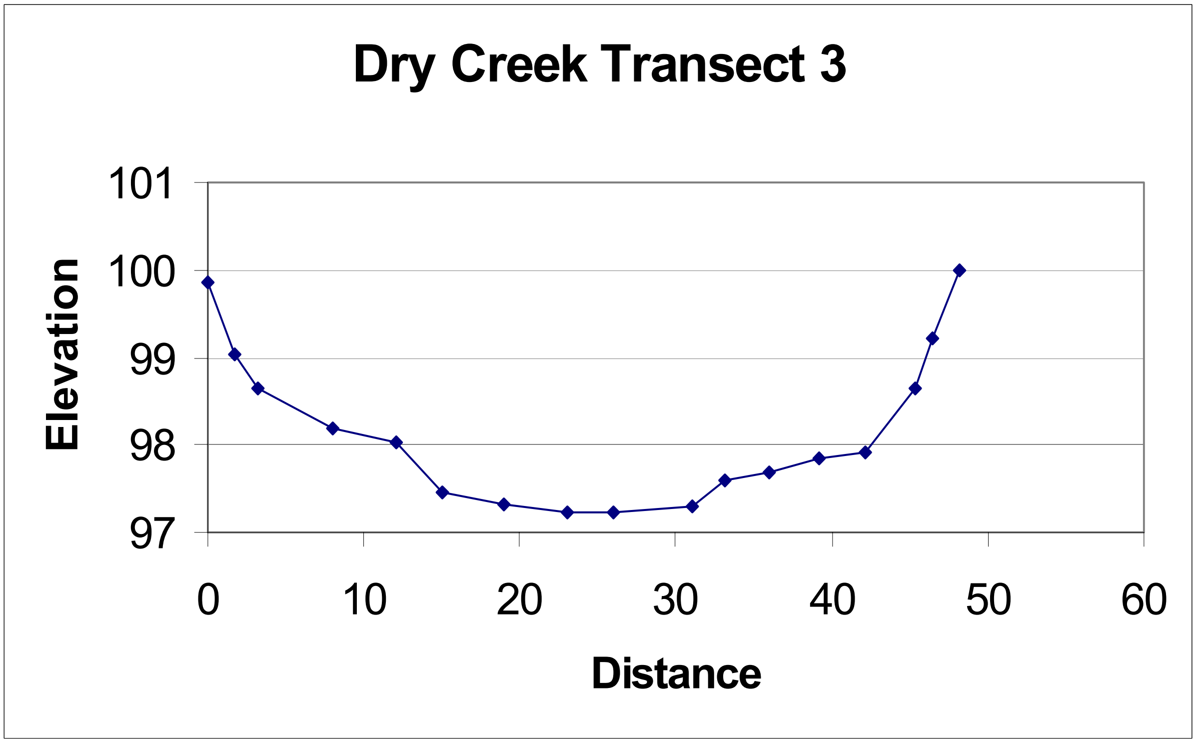
1 High end of range
2 Low end of range
3 Good habitat at top of riffle, small substrate somewhat limiting
4 Good substrate, marginal depths
5 BH - suitable 40- 60%
6 Different locations for steelhead vs chinook, but still a large area available
7 Shallow, but otherwise suitable spawning habitat
8 Small area of suitable spawning; same area for optimal
9 More habitat for steelhead than chinook, but still in 10 - 25% range
10 TT/RF- Next lower category for suitable
11 Substrate limiting
12 Sandy substrate, low complexity, poor habitat
13 Some small areas, debate as to whether it is 10%
14 Good substrates, but velocity much too high
15 Poor-Fair hydraulics; too deep, not great substrate

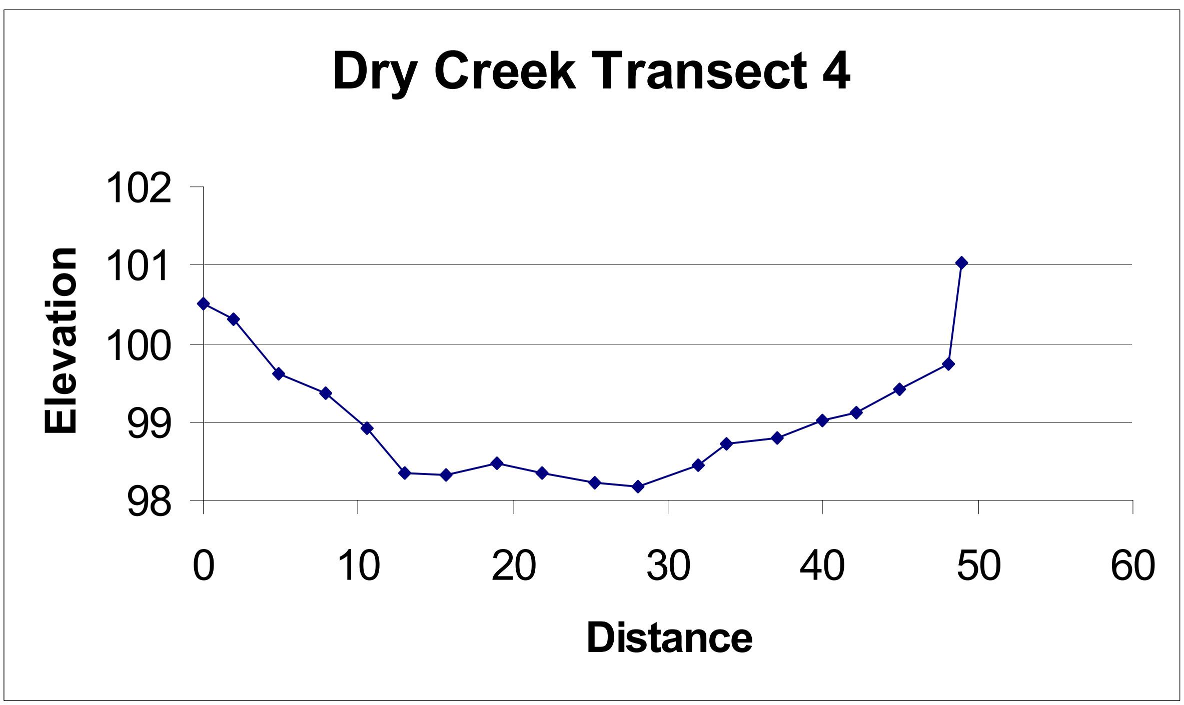
ATTACHMENT D

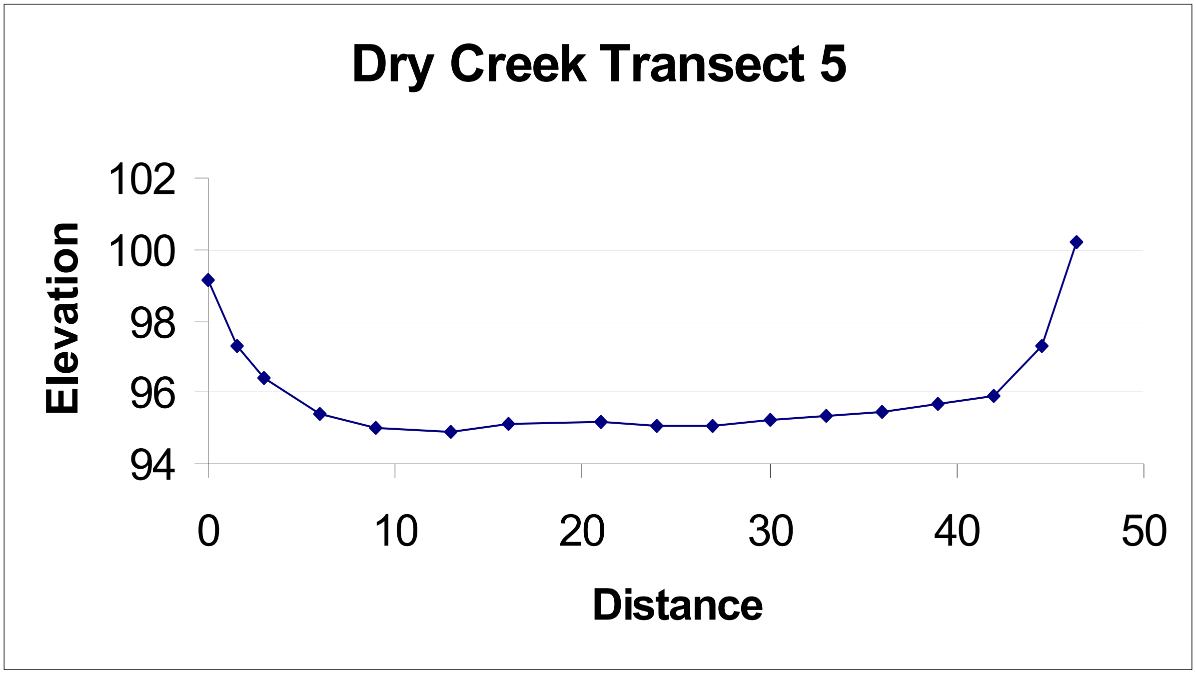
CROSS SECTIONAL PROFILES AT TRANSECTS

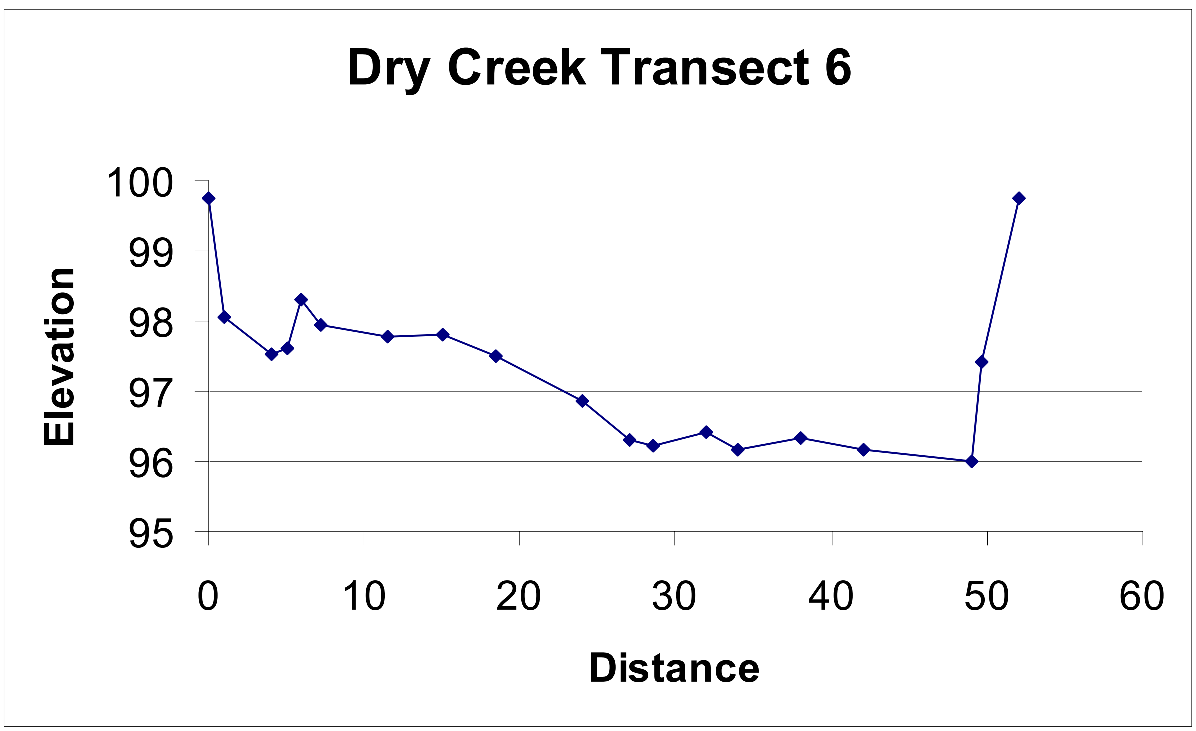

Dry Creek Transect 1
Elevation
102
101
100
99
98
97
96
0
20
40
60
80
100
Distance

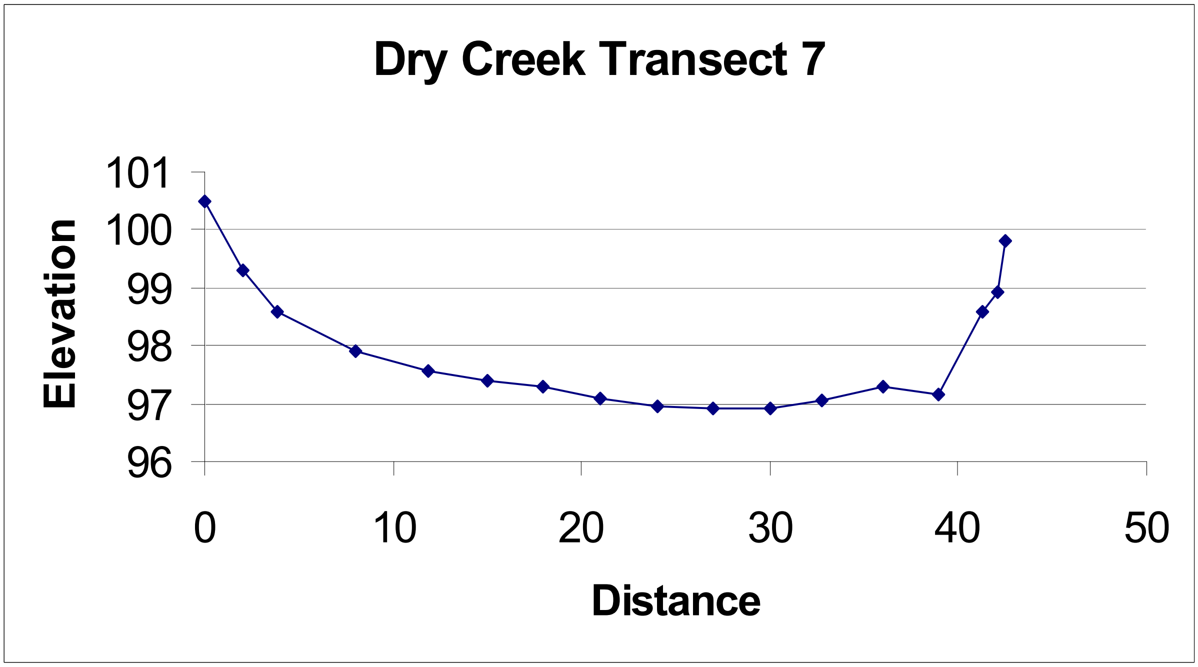

Dry Creek Transect 2
Elevation
101
100
99
98
97
96
95
0
10
20
30
40
50
60
Distance

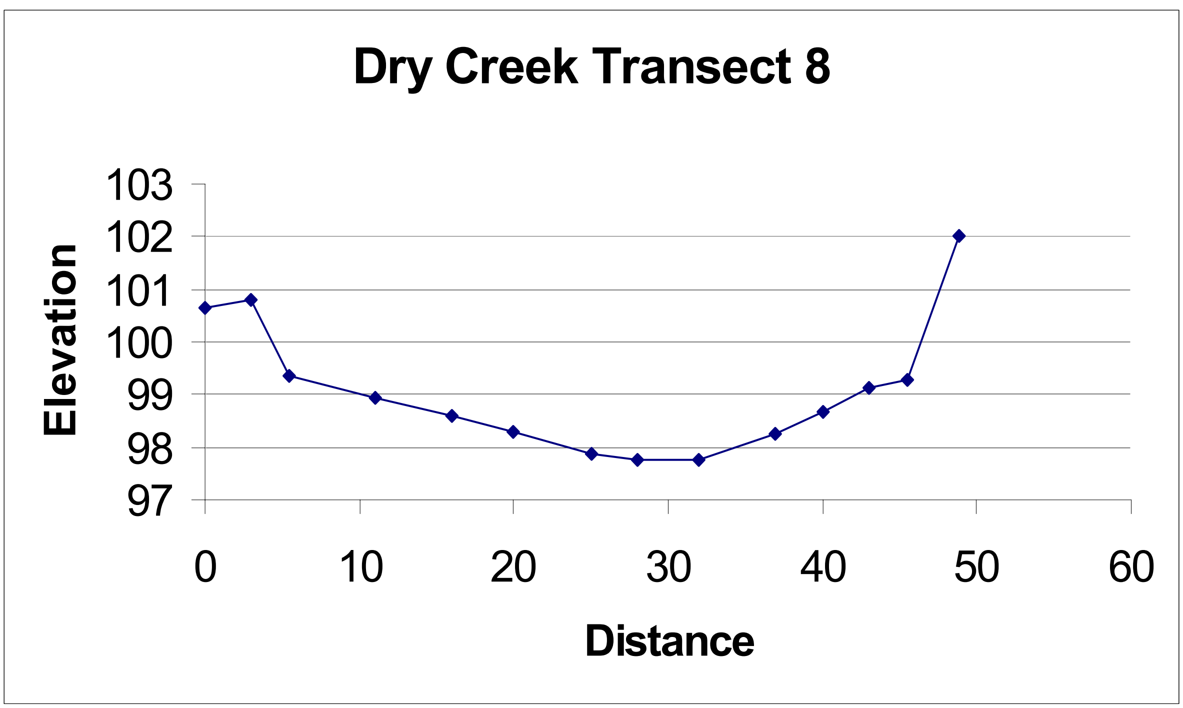

Dry Creek Transect 3
Elevation
101
100
99
98
97
0
10
20
30
40
50
60
Distance

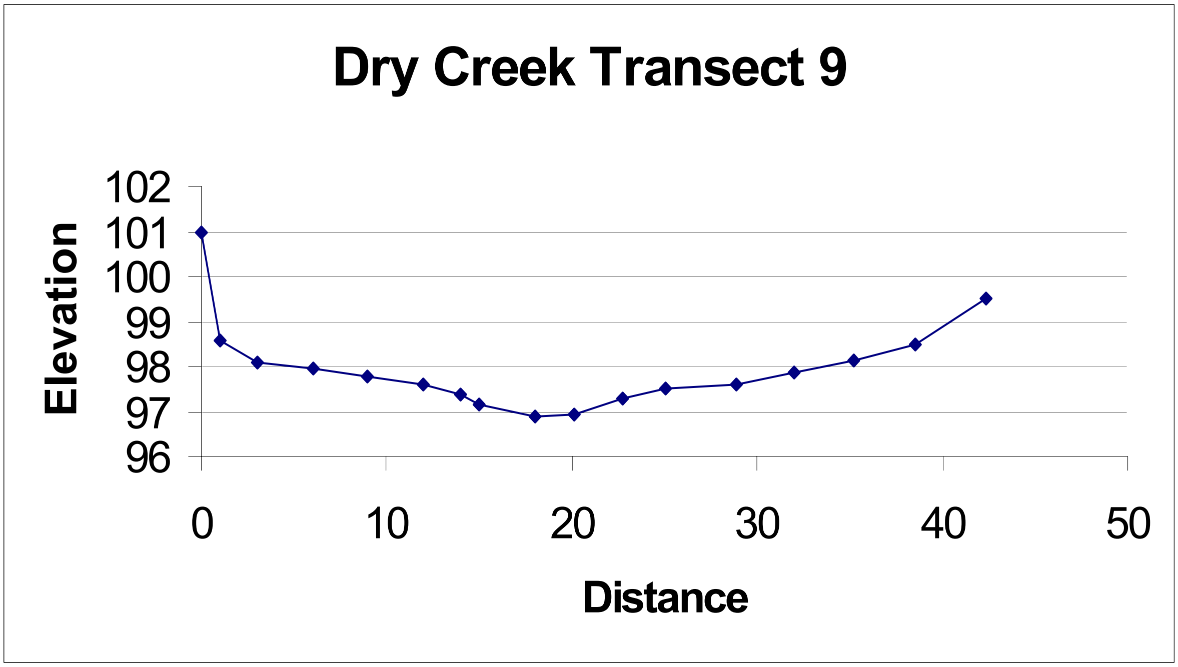

Dry Creek Transect 4
Elevation
102
101
100
99
98
0
10
20
30
40
50
60
Distance

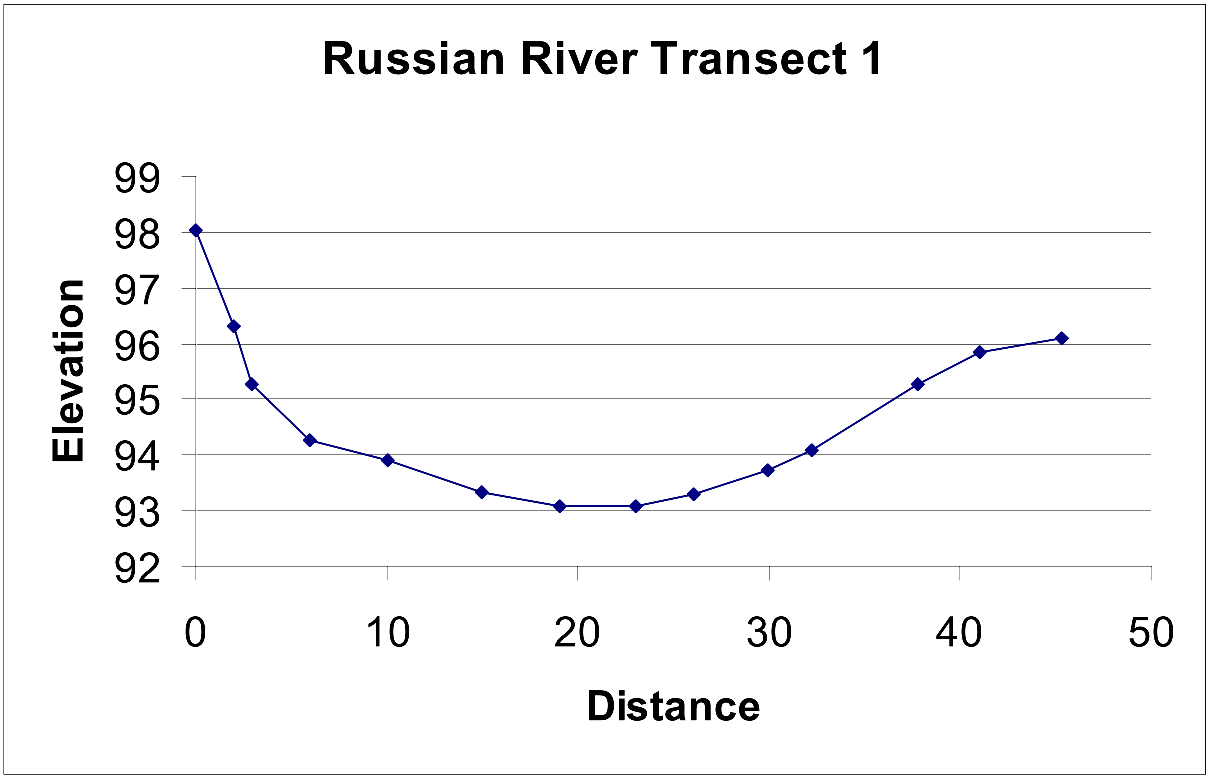

Dry Creek Transect 5
Elevation
102
100
98
96
94
0
10
20
30
40
50
Distance

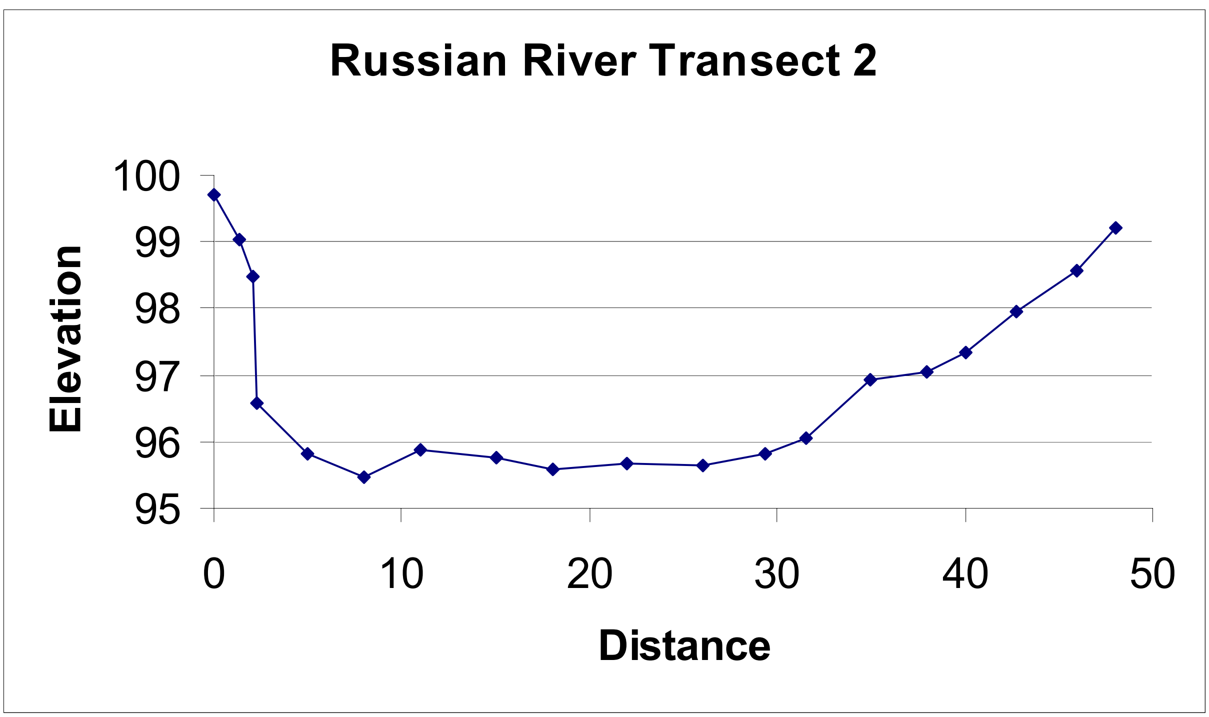

Dry Creek Transect 6
Elevation
100
99
98
97
96
95
0
10
20
30
40
50
60
Distance

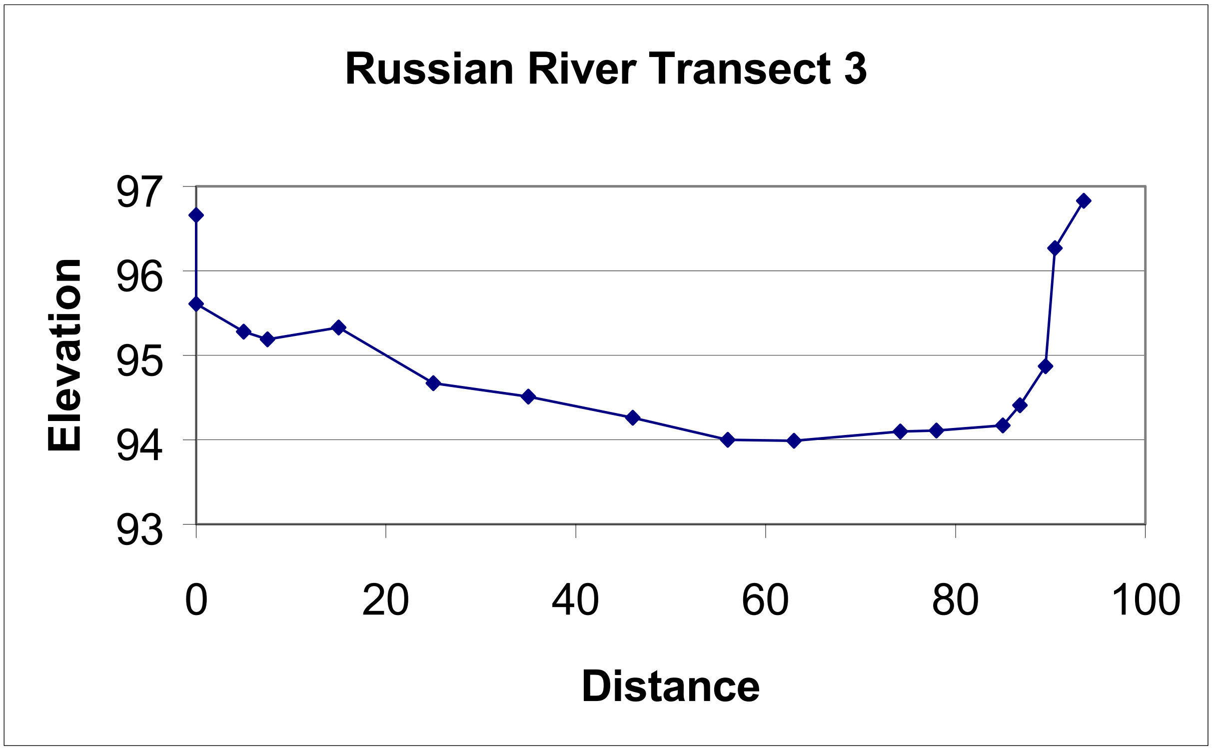

Dry Creek Transect 7
Elevation
101
100
99
98
97
96
0
10
20
30
40
50
Distance

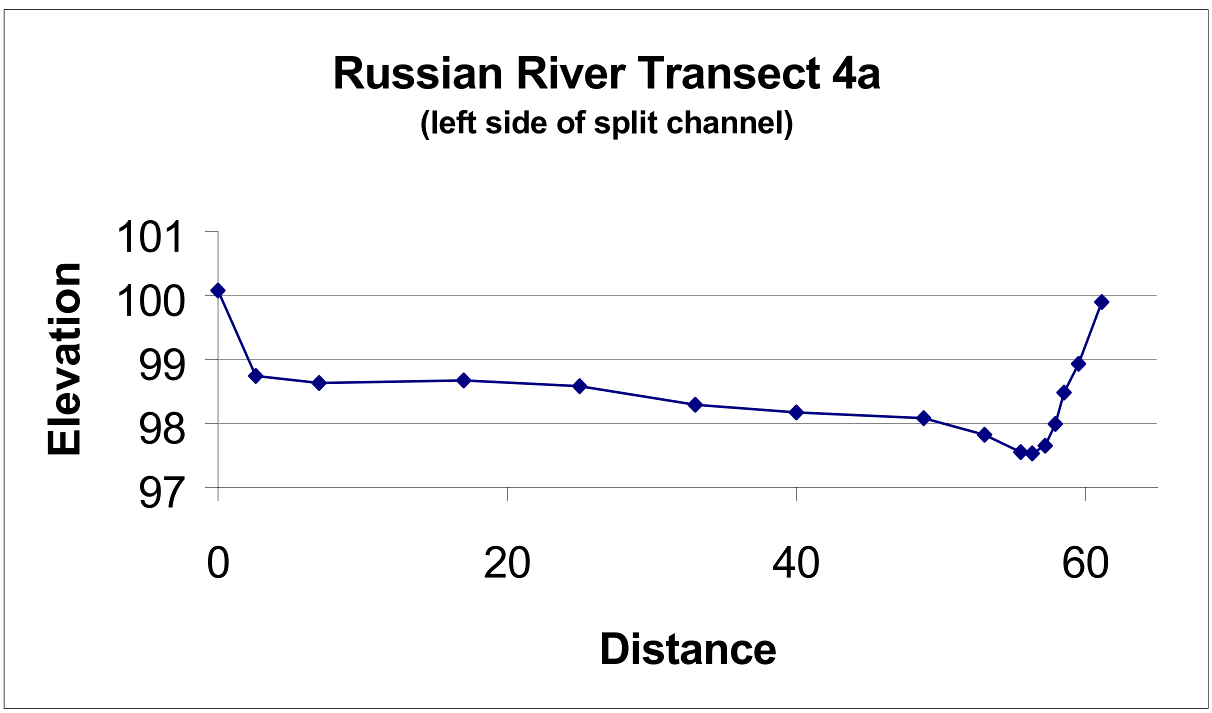

Dry Creek Transect 8
Elevation
103
102
101
100
99
98
97
0
10
20
30
40
50
60
Distance

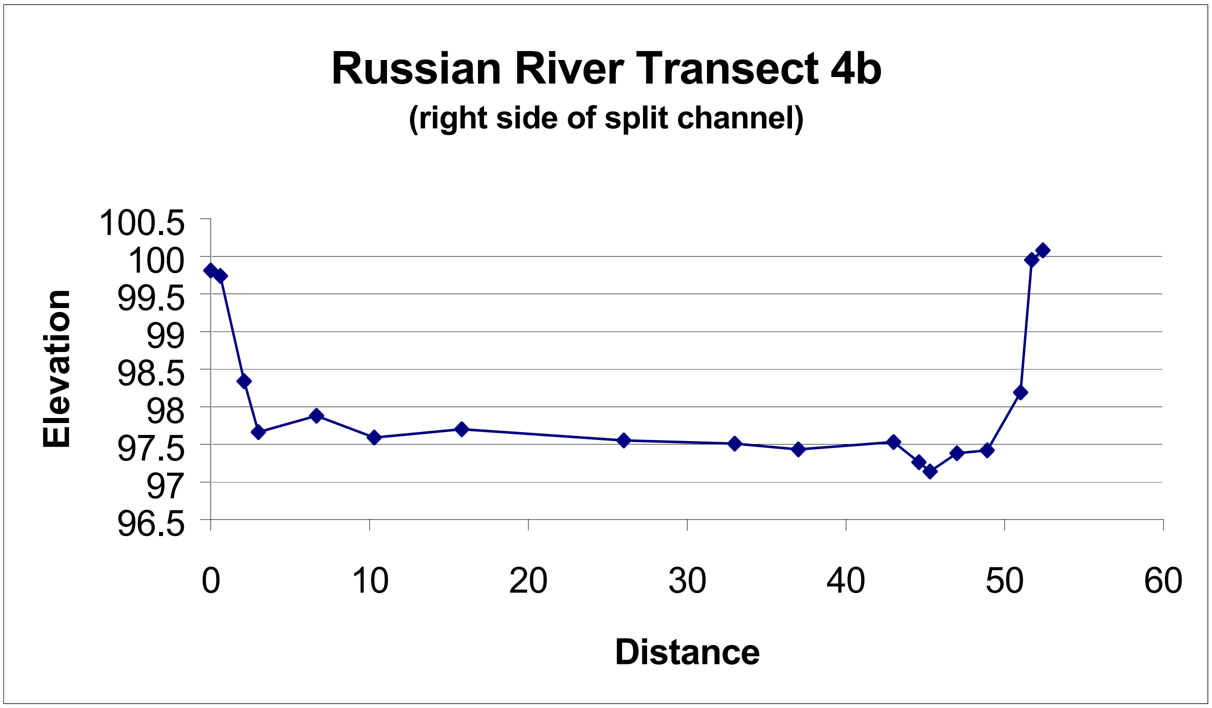

Dry Creek Transect 9
Elevation
102
101
100
99
98
97
96
0
10
20
30
40
50
Distance

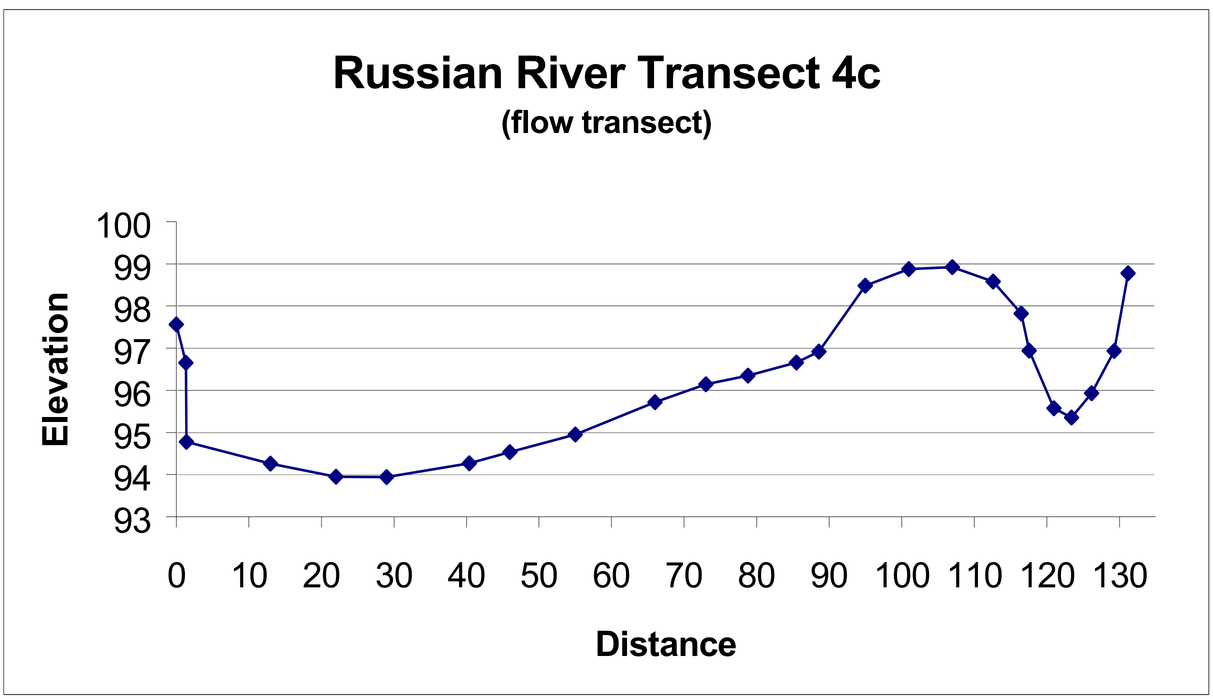

Russian River Transect 1
Elevation
99
98
97
96
95
94
93
92
0
10
20
30
40
50
Distance

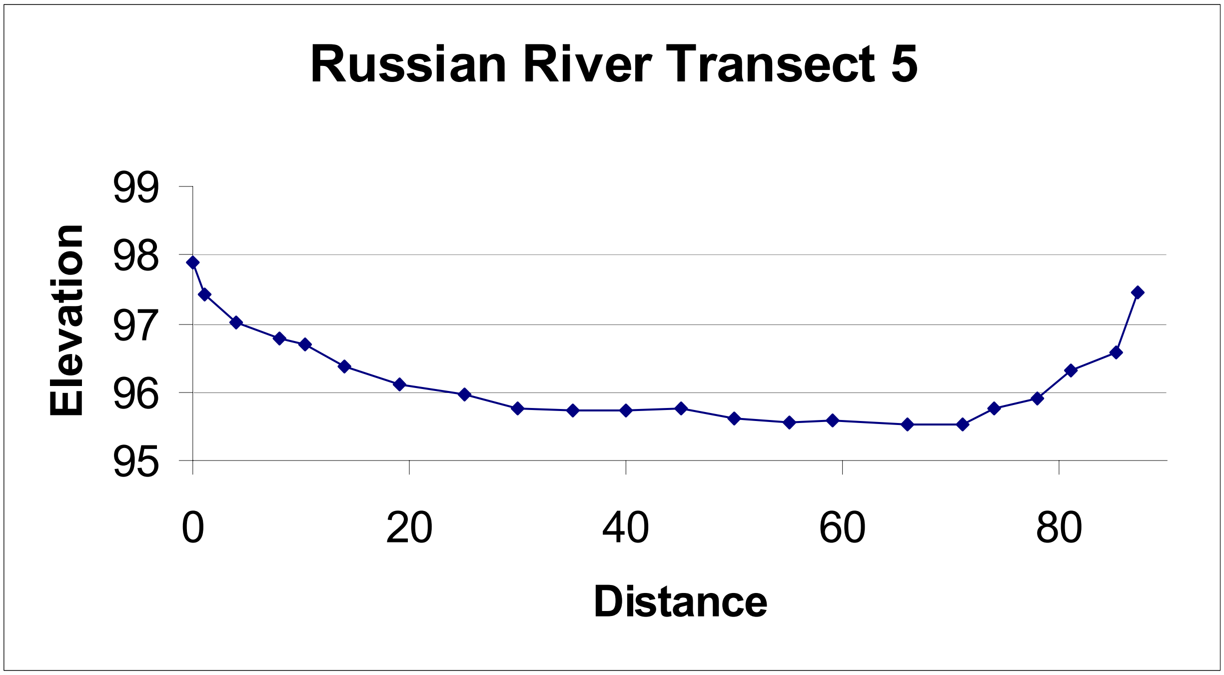

Russian River Transect 2
Elevation
100
99
98
97
96
95
0
10
20
30
40
50
Distance

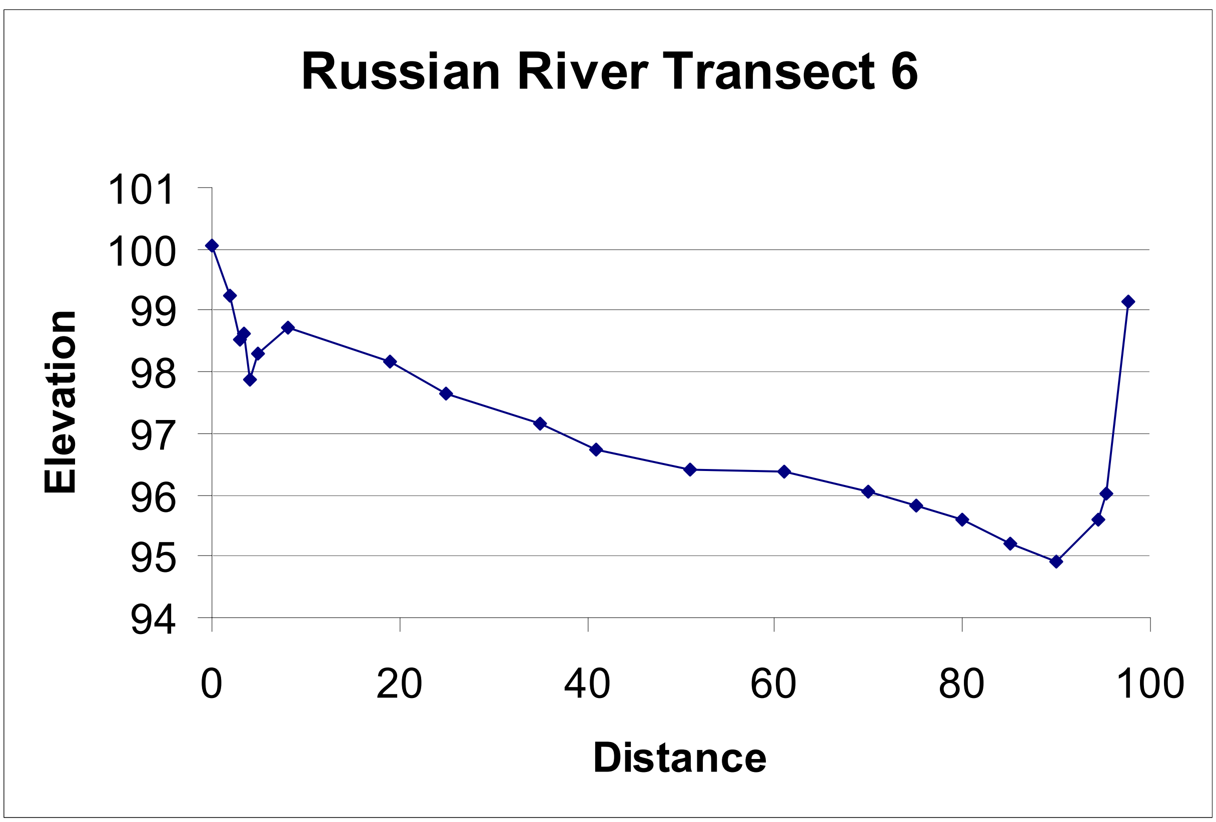

Russian River Transect 3
Elevation
97
96
95
94
93
0
20
40
60
80
100
Distance

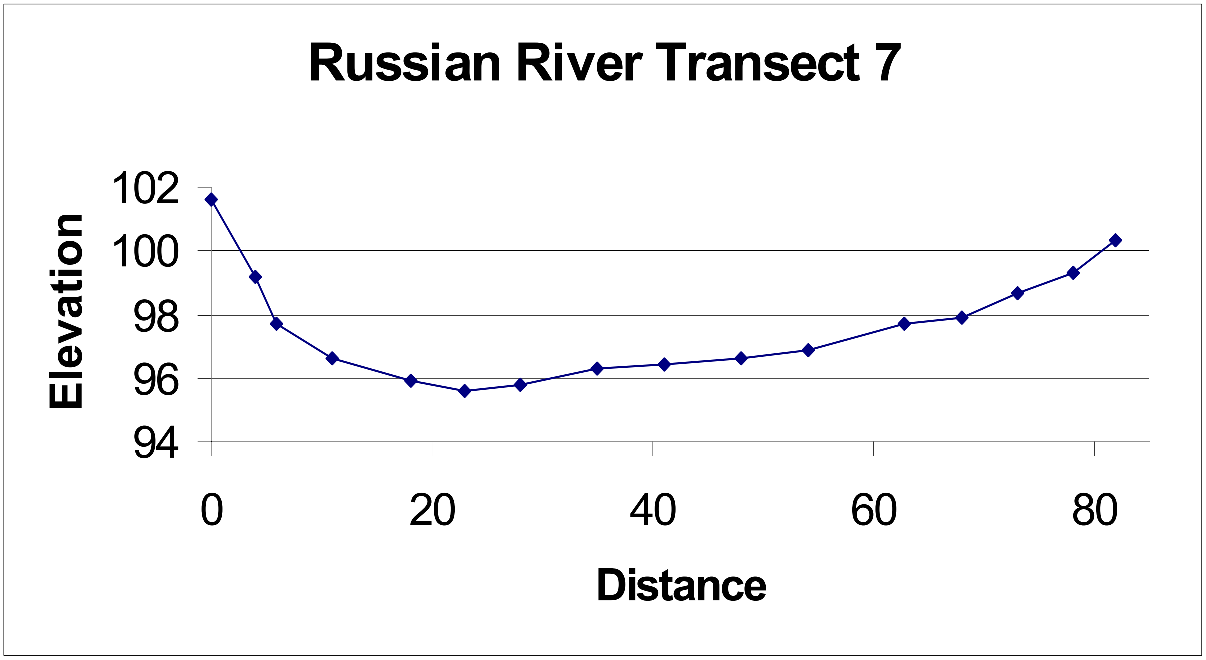

Russian River Transect 4a
(left side of split channel)
Elevation
101
100
99
98
97
0
20
40
60
Distance

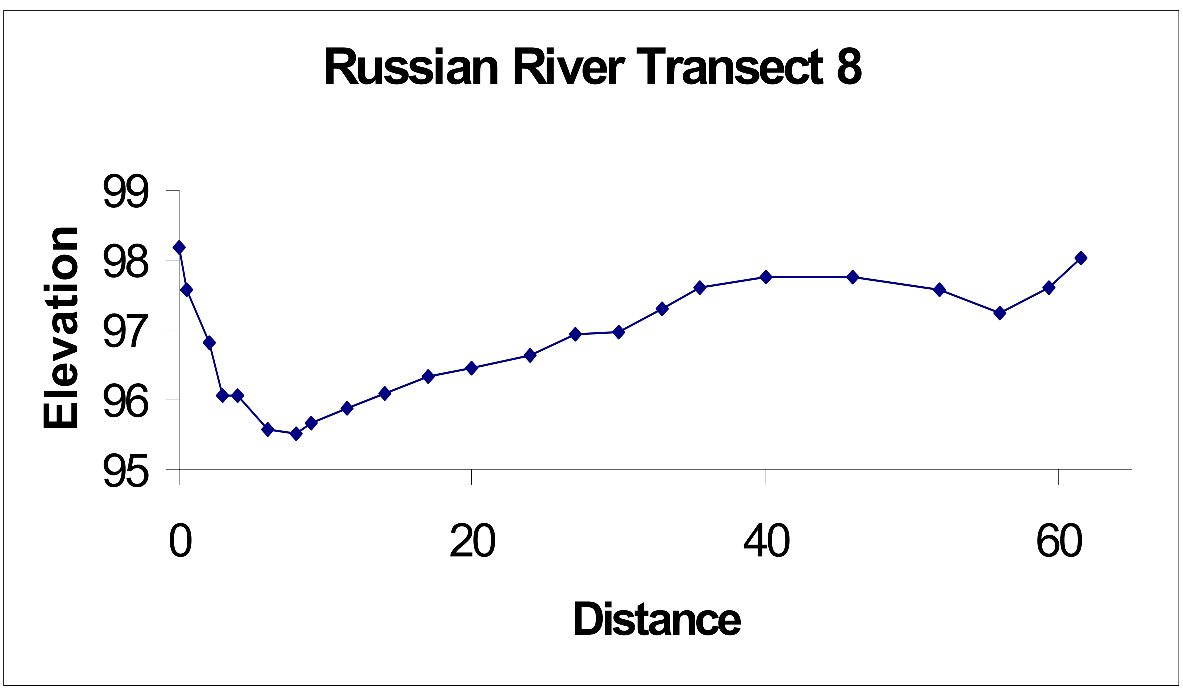

Russian River Transect 4b
(right side of split channel)
Elevation
100.5
100
99.5
99
98.5
98
97.5
97
96.5
0
10
20
30
40
50
60
Distance

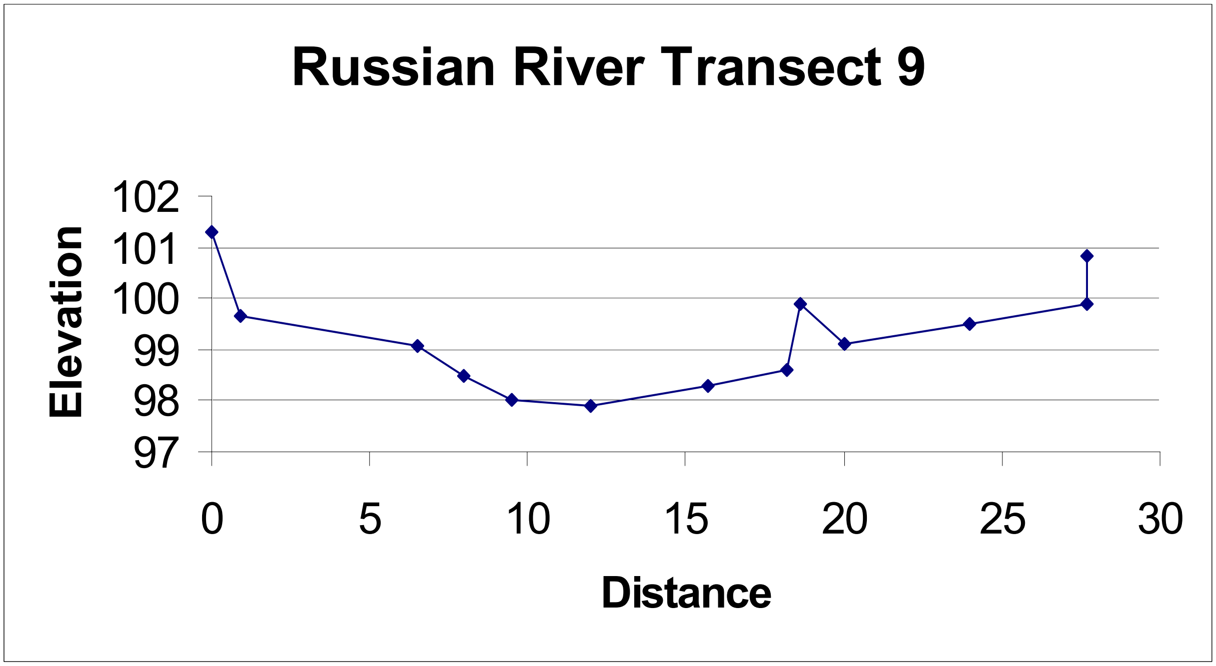

Russian River Transect 4c
(flow transect)
Elevation
100
99
98
97
96
95
94
93
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Distance

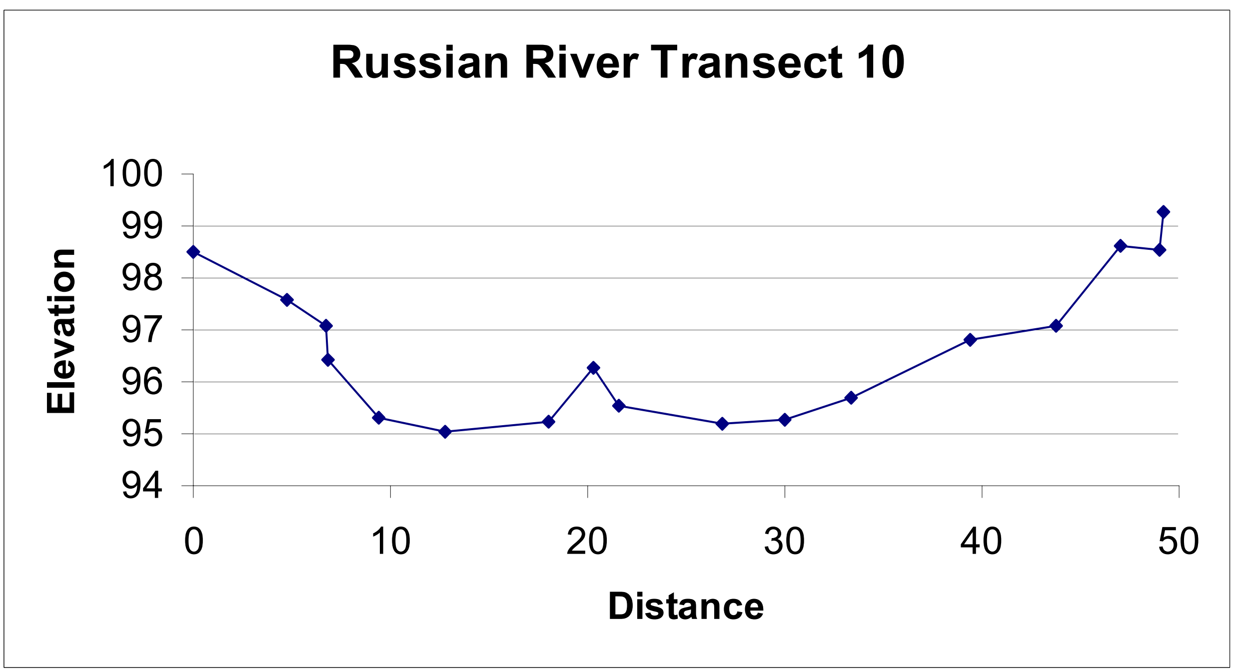

Russian River Transect 5
99
98
97
96
95
Elevation
0
20
40
60
80
Distance

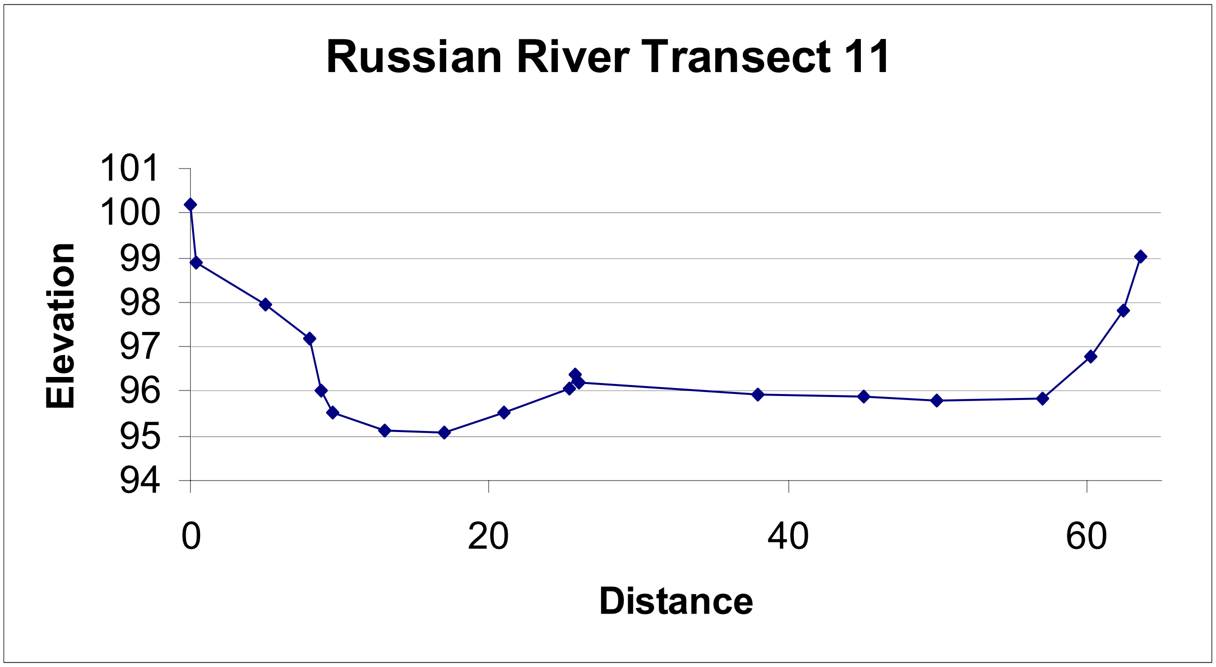

Russian River Transect 6
101
100
99
98
97
96
95
94
Elevation
0
20
40
60
80
100
Distance

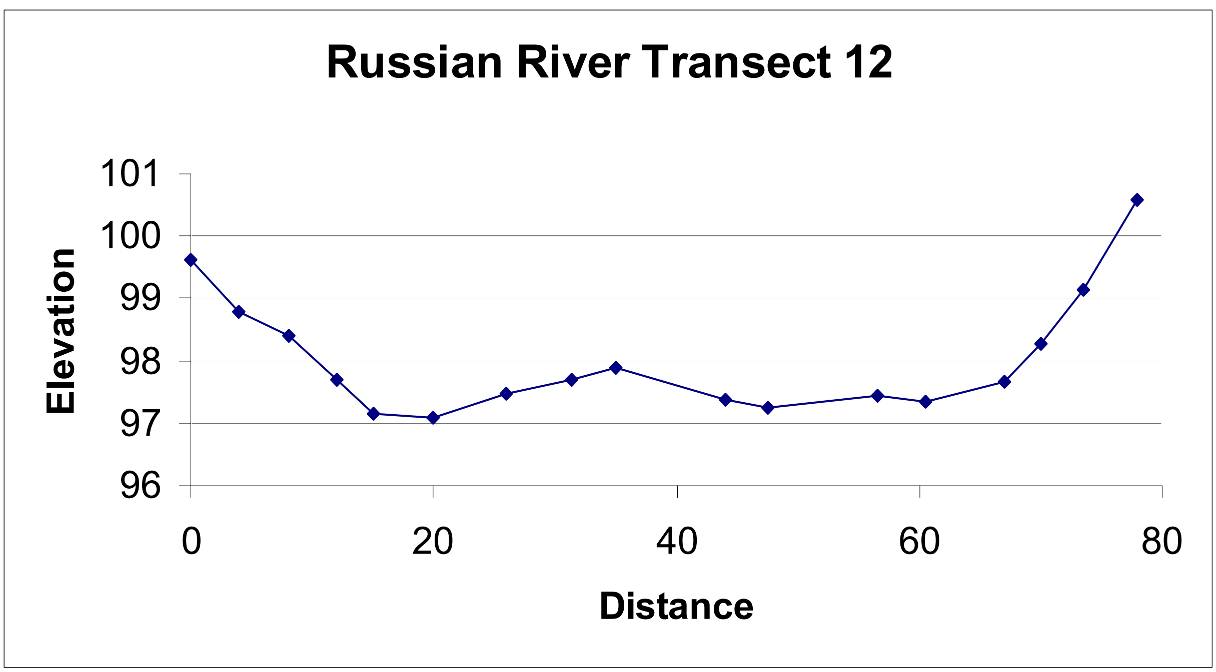

Russian River Transect 7
Elevation
102
100
98
96
94
0
20
40
60
80
Distance

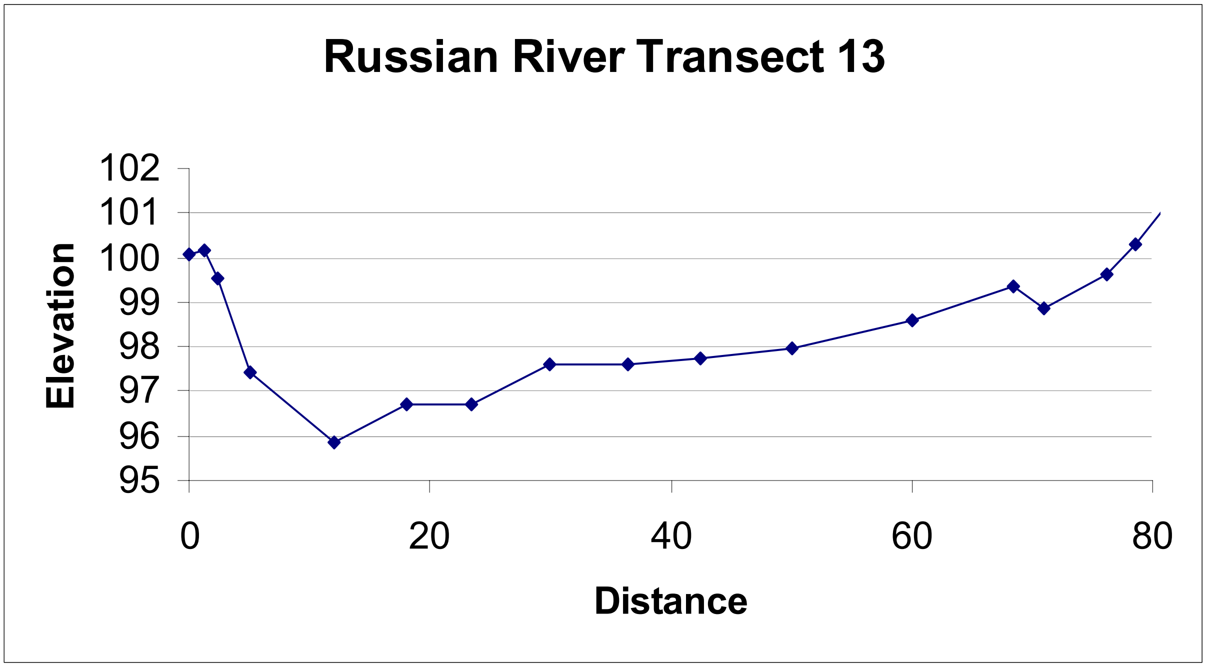

Russian River Transect 8
Elevation
99
98
97
96
95
0
20
40
60
Distance


Russian River Transect 9
Elevation
102
101
100
99
98
97
0
5
10
15
20
25
30
Distance


Russian River Transect 10
Elevation
100
99
98
97
96
95
94
0
10
20
30
40
50
Distance


Russian River Transect 11
101
100
99
98
97
96
95
94
Elevation
0
20
40
60
Distance


Russian River Transect 12
101
100
99
98
97
96
Elevation
0
20
40
60
80
Distance


Russian River Transect 13
102
101
100
99
98
97
96
95
Elevation
0
20
40
60
80
Distance

ATTACHMENT E

DEPTHS AND VELOCITIES AT TRANSECTS AND SUMMARY OF HYDRAULIC MEASUREMENTS

Dry Creek Transect 1 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	***Release Flow: 47 cfs***		
1	13.3	1.5	0.27
2	19.5	2.18	0.39
3	26.0	2.1	0.53
4	32.5	1.95	0.62
5	39.0	1.8	0.58
6	45.5	1.55	0.32
7	52.0	1.45	0.2
8	58.5	1.55	0.22
9	65.0	1.45	0.9
10	71.5	0.85	0.01
9/19/01	***Release Flow: 90 cfs***		
1	17.0	2.5	0.57
2	24.0	2.6	0.96
3	31.0	2.45	1.01
4	38.0	2.2	1.00
5	45.0	1.9	0.56
6	52.0	1.8	0.47
7	59.0	2	0.36
8	66.0	1.7	0.08
9	73.0	0.85	0.04
10	80.0	0	0.00

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	***Release Flow: 130 cfs***		
1	16	2.4	0.67
2	23	2.9	1.19
3	30	2.65	1.2
4	37	2.35	1.45
5	44	2.05	1.1
6	51	2.05	0.7
7	58	2.05	0.57
8	65	2.05	0.26
9	72	1.35	0.1
9/21/01	***Release Flow: 150 cfs***		
1	15	2.45	0.85
2	21	2.9	1.30
3	27	2.75	1.47
4	33	2.75	1.27
5	39	2.45	1.44
6	45	2.3	0.89
7	51	2.15	0.57
8	57	2.2	0.56
9	66	2	0.23
10	72	1.4	0.12

Reported velocities are Mean Column Velocities

Dry Creek Transect 2 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	***Release Flow: 47 cfs***		
1	8.0	0.2	0.28
2	11.5	0.35	0.43
3	15.0	0.2	2.21
4	18.5	0.5	0.72
5	22.0	0.4	0.63
6	25.5	0.55	1.27
7	29.0	0.6	1.16
8	32.5	1.1	1.87
9	36.0	1.5	2.72
10	39.5	1.4	1.84
9/19/01	***Release Flow: 90 cfs***		
1	6.0	0.1	0.06
2	10.0	0.4	0.68
3	14.0	0.4	2.76
4	18.0	0.9	1.57
5	22.0	0.65	2.87
6	26.0	0.95	1.68
7	30.0	1.3	2.81
8	34.0	1.8	4.13
9	38.0	1.95	2.26
10	40.0	1.8	2.00

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	***Release Flow: 130 cfs***		
1	5	0.3	0
2	8	0.65	0.29
3	11	0.75	1.35
4	14	0.6	2.79
5	17	1	1.05
6	20	1	3.42
7	23	1.05	1.87
8	26	1.2	2.45
9	29	1.4	3.95
10	32	1.6	5.12
11	35	2.1	3.82
12	38	2.2	2.29
13	41	1.7	1.63
9/21/01	***Release Flow: 150 cfs***		
1	5	0.4	0.01
2	9	0.8	1.71
3	13	0.9	2.4
4	17	1.3	2.04
5	21	1.1	3.02
6	25	1.4	3.14
7	29	1.65	4.05
8	31	1.8	5.86
9	33	2	3.74
10	37	2.3	2.23
11	41	1.8	1.43

Reported velocities are Mean Column Velocities

Dry Creek Transect 2B - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	***Release Flow: 47 cfs***		
1	1.6	0.2	0.01
2	3.2	0.2	0.18
3	4.8	0.35	0.39
4	6.4	0.4	0.72
5	8.0	0.45	0.69
6	9.6	0.8	1.08
7	11.2	1.05	1.28
8	12.8	1.2	1.55
9	14.4	1.1	1.95
10	16.0	1.1	1.69
11	17.6	1.1	1.98
12	19.2	1.05	2.04
13	20.8	0.9	2.08
14	22.4	0.9	2.23
15	24.0	0.7	2.11
16	25.6	0.7	2.51
17	27.2	0.6	1.98
18	28.8	0.6	1.59
19	30.4	0.6	1.3
20	32.0	0.6	1.13
21	33.6	0.5	0.96
22	35.2	0.15	0.54
9/19/01	***Release Flow: 90 cfs***		
1	1	0.15	0.01
2	3	0.4	0.01
3	5	0.55	0.02
4	7	0.7	0.57
5	9	0.8	0.69
6	11	0.85	1.46
7	13	1.05	1.89
8	15	1.25	2.27
9	17	1.45	2.62
10	19	1.25	2.68
11	21	1.3	3.2
12	23	1.15	3.44
13	25	1.05	3.4
14	27	1.1	3.68
15	29	1	3.35
16	31	0.9	3.55
17	33	0.95	2.81
18	35	0.85	2.78
19	37	0.75	2.28
20	39	0.55	1.78
21	41	0.35	1.03
22	43	0.1	0.01

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	***Release Flow: 130 cfs***		
1	2	0.55	0.48
2	4	0.8	0.99
3	6	0.95	1.55
4	8	1	1.58
5	10	1.2	1.74
6	12	1.25	1.95
7	14	1.45	2.37
8	16	1.5	2.83
9	18	1.5	3.13
10	20	1.4	3.4
11	22	1.4	3.61
12	24	1.45	3.78
13	26	1.3	3.78
14	28	1.3	3.77
15	30	1.2	3.78
16	32	1.15	3.32
17	34	1.15	2.9
18	36	1	2.61
19	38	1	2.97
20	40	0.6	1.13
21	42	0.4	0.51
9/21/01	***Release Flow: 150 cfs***		
1	1	0.45	0.01
2	3	0.7	0.86
3	5	0.9	2.11
4	7	1.2	2.31
5	9	1.35	2
6	11	1.45	1.92
7	13	1.45	2.66
8	15	1.35	2.9
9	17	1.7	3.2
10	19	1.7	3.41
11	21	1.6	3.54
12	23	1.6	3.79
13	25	1.6	4.02
14	27	1.45	3.8
15	29	1.45	3.79
16	31	1.3	3.67
17	33	1.3	3.41
18	35	1.25	3.31
19	37	1.2	2.8
20	39	1.2	1.8
21	41	0.85	1.12
22	43	0.7	0.6
23	44	0.25	0.29

Reported velocities are Mean Column Velocities

Dry Creek Transect 3 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	***Release Flow: 47 cfs***		
1	4.4	0.1	0.01
2	6.4	0.2	0.48
3	8.4	0.4	0.46
4	10.4	0.4	0.14
5	12.4	0.6	0.49
6	14.4	1	0.65
7	16.4	1.1	1.2
8	18.4	1.25	1.54
9	20.4	1.2	1.34
10	22.4	1.35	1.68
11	24.4	1.2	1.66
12	26.4	1.25	1.27
13	28.4	1.2	1.15
14	30.4	1.25	1.1
15	32.4	1	1.09
16	34.4	0.8	1.13
17	36.4	0.8	1.37
18	38.4	0.7	1.29
19	40.4	0.75	1.32
20	42.4	0.65	0.88
21	44.4	0.2	0.09
9/19/01	***Release Flow: 90 cfs***		
1	4.4	0.4	0.88
2	6.4	0.35	0.75
3	8.4	0.65	0.65
4	10.4	0.7	0.81
5	12.4	0.9	0.91
6	14.4	1.3	1.35
7	16.4	1.45	2.03
8	18.4	1.55	2.27
9	20.4	1.55	2.1
10	22.4	1.65	2.29
11	24.4	1.6	2.17
12	26.4	1.5	2.07
13	28.4	1.6	1.93
14	30.4	1.65	1.77
15	32.4	1.4	1.98
16	34.4	1.15	1.94
17	36.4	1.15	2.1
18	38.4	1.05	2.01
19	40.4	1.1	1.93
20	42.4	1	1.4
21	44.4	0.5	0.89

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	***Release Flow: 130 cfs***		
1	4.1	0.6	1.02
2	6.1	0.5	1.1
3	8.1	0.9	1.25
4	10.1	0.85	1.29
5	12.1	1	1.26
6	14.1	1.5	1.63
7	16.1	1.6	2.55
8	18.1	1.8	2.85
9	20.1	1.85	2.84
10	22.1	1.9	2.68
11	24.1	1.8	2.81
12	26.1	1.8	2.63
13	28.1	1.8	2.41
14	30.1	1.85	2.21
15	32.1	1.6	2.42
16	34.1	1.4	2.69
17	36.1	1.4	2.46
18	38.1	1.3	2.48
19	40.1	1.3	2.86
20	42.1	1.15	2.15
21	44.1	0.75	1.32
9/21/01	***Release Flow: 150 cfs***		
1	2.6	0.2	0.13
2	4.6	0.75	1.4
3	6.6	0.9	1.87
4	8.6	1.05	1.28
5	10.6	1	1.45
6	12.6	1.15	2
7	14.6	1.75	2.26
8	16.6	1.8	2.89
9	18.6	1.95	3.01
10	20.6	2	2.87
11	22.6	2.05	3.36
12	24.6	2	2.9
13	26.6	1.95	2.73
14	28.6	1.95	2.38
15	30.6	2	2.35
16	32.6	1.75	2.76
17	34.6	1.5	2.75
18	36.6	1.45	2.88
19	38.6	1.4	2.84
20	40.6	1.5	2.87
21	42.6	1.35	2.23
22	44.6	0.9	0.92
23	45.6	0.4	0.24

Reported velocities are Mean Column Velocities

Dry Creek Transect 4 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	***Release Flow: 47 cfs***		
1	12.7	0.8	2.25
2	16.1	0.9	2.08
3	19.5	0.7	2.85
4	22.9	0.9	2.32
5	26.3	1	2.44
6	29.7	1.1	1.61
7	33.1	0.55	0.68
8	36.5	0.35	0.31
9	39.9	0.2	0.29
10	43.3	0	0
9/19/01	***Release Flow: 90 cfs***		
1	8.3	0.2	0.19
2	11.3	0.85	1.67
3	14.3	1.35	2.6
4	17.3	1.15	3.33
5	20.3	1.15	3.59
6	23.3	1.25	3.57
7	26.3	1.4	3.88
8	29.3	1.4	2.29
9	32.3	1.15	2.32
10	35.3	0.8	2.07
11	38.3	0.6	1.54
12	41.3	0.55	0.63
13	44.3	0.2	0.28

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	***Release Flow: 130 cfs***		
1	6.2	0.25	0.66
2	9.2	0.55	1
3	12.2	1.3	2.44
4	15.2	1.4	3.52
5	18.2	1.4	4.27
6	21.2	1.4	3.97
7	24.2	1.5	4
8	27.2	1.7	3.48
9	30.2	1.8	3.03
10	33.2	1.3	3.03
11	36.2	1.1	2.61
12	39.2	0.85	1.84
13	42.2	0.7	1.16
14	45.2	0.45	1.52
15	48.2	0.1	0.01
9/21/01	***Release Flow: 150 cfs***		
1	6.7	0.4	1.04
2	10.7	1.15	2.22
3	14.7	1.75	2.99
4	18.7	1.55	3.94
5	22.7	1.75	3.7
6	26.7	1.85	3.27
7	30.7	1.9	3.35
8	34.7	1.35	3.4
9	38.7	1.05	2.45
10	42.7	0.8	0.71
11	46.7	0.5	0.75

Reported velocities are Mean Column Velocities

Dry Creek Transect 5 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	***Release Flow: 47 cfs***		
1	4	1.55	0.19
2	8	2.1	0.38
3	12	2.4	0.51
4	16	2.05	0.55
5	20	2.1	0.73
6	24	2.1	0.7
7	28	2.1	0.57
8	32	1.95	0.55
9	36	1.8	0.47
10	40	1.6	0.45
9/19/01	***Release Flow: 90 cfs***		
1	4	1.95	0.04
2	8	2.5	0.54
3	12	2.75	0.64
4	16	2.45	0.86
5	20	2.45	1.14
6	24	2.4	1.25
7	28	2.3	1.13
8	32	2.3	0.99
9	36	2.15	0.84
10	40	1.95	0.74
11	43	1.5	0.41

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	***Release Flow: 130 cfs***		
1	5.5	2.45	0.53
2	9.5	2.9	0.72
3	13.5	2.7	0.89
4	17.5	2.8	1.21
5	21.5	2.7	1.50
6	25.5	2.65	1.39
7	29.5	2.6	1.29
8	33.5	2.55	1.15
9	37.5	2.4	1.01
10	41.5	2.2	0.95
9/21/01	***Release Flow: 150 cfs***		
1	3.4	2.2	0.51
2	7.4	2.8	0.84
3	11.4	3.2	1.015
4	15.4	2.9	1.245
5	19.4	2.95	1.67
6	23.4	3	1.78
7	27.4	2.9	1.655
8	31.4	2.6	1.41
9	35.4	2.6	1.24
10	39.4	2.4	0.97
11	43.4	1.6	0.11

Reported velocities are Mean Column Velocities

Dry Creek Transect 6 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	***Release Flow: 47 cfs***		
1	19	0.1	0.01
2	20.5	0.15	0.11
3	22	0.5	0.34
4	23.5	0.7	0.45
5	25	0.8	0.88
6	26.5	1	0.65
7	28	1.2	0.79
8	29.5	1.05	1.19
9	31	1.1	1.16
10	32.5	1	1.07
11	34	1.3	1.25
12	35.5	1.1	1.33
13	37	1.1	1.62
14	38.5	1.2	1.29
15	40	1.2	1.22
16	41.5	1.35	1.65
17	43	1.35	1.53
18	44.5	1.3	1.78
19	46	1.35	1.66
20	47.5	1.3	1.63
21	49	1.3	1.12
22	49.75	0.1	0.01
9/19/01	***Release Flow: 90 cfs***		
1	17.7	0.1	0.01
2	19.4	0.5	0.38
3	21.1	0.7	0.79
4	22.8	0.85	1.18
5	24.5	1.05	1.44
6	26.2	1.25	1.32
7	27.9	1.5	1.76
8	29.6	1.55	2.08
9	31.3	1.35	1.77
10	33	1.55	2.1
11	34.7	1.5	2.05
12	36.4	1.45	2.28
13	38.1	1.4	2.31
14	39.8	1.5	2.31
15	41.5	1.65	2.03
16	42.2	1.6	2.08
17	43.9	1.6	2.41
18	45.6	1.6	2.24
19	47.3	1.8	2.16
20	49	1.65	1.6

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	***Release Flow: 130 cfs***		
1	19	0.6	0.51
2	20.6	0.75	1.63
3	22.2	1.1	1.61
4	23.8	1.2	1.6
5	25.4	1.4	2.02
6	27	1.7	2.49
7	28.6	1.75	1.8
8	30.2	1.75	2.86
9	31.8	1.75	2.51
10	33.4	1.85	2.52
11	35	1.8	2.78
12	36.6	1.7	2.74
13	38.2	1.65	2.71
14	39.8	1.65	2.83
15	41.4	2	2.7
16	43	1.95	2.71
17	44.6	1.9	2.77
18	46.2	1.9	2.67
19	47.8	2	2.56
20	49.4	0.5	1.25
9/21/01	***Release Flow: 150 cfs***		
1	8	0.2	0.59
2	10	0.35	1.1
3	12	0.4	0.82
4	14	0.3	0.31
5	16	0.3	1.18
6	18	0.45	1.11
7	20	0.8	1.75
8	22	1.25	1.97
9	24	1.5	2.04
10	26	1.65	2.21
11	28	1.95	1.91
12	30	1.95	3.37
13	32	1.75	3.02
14	34	2	2.92
15	36	1.85	3.1
16	38	1.95	3.02
17	40	2	2.88
18	42	2.15	2.69
19	44	2	3.38
20	46	2.15	3.06
21	48	2.2	2.81
22	50	0.65	0.77

Reported velocities are Mean Column Velocities

Dry Creek Transect 7 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	*Release Flow: 47 cfs*		
1	5.5	0.3	0.35
2	7.1	0.52	0.48
3	8.7	0.65	0.84
4	10.3	0.8	1.05
5	11.9	1	0.98
6	13.5	1	1.09
7	15.1	1.1	1.27
8	16.7	1.2	1.27
9	18.3	1.25	1.53
10	19.9	1.35	1.24
11	21.5	1.5	1.52
12	23.1	1.6	1.6
13	24.7	1.6	1.4
14	26.3	1.65	1.23
15	27.9	1.65	1.08
16	29.5	1.6	0.85
17	31.1	1.6	0.69
18	32.7	1.5	0.44
19	34.3	1.4	0.28
20	35.9	1.25	0.25
21	37.5	1.4	0.17
22	39.1	1.5	0.03
23	40.7	0.1	0.01
9/19/01	*Release Flow: 90 cfs*		
1	3.9	0.25	0.15
2	5.5	0.55	0.89
3	7.1	0.8	1.05
4	8.7	1	1.33
5	10.3	1.1	1.49
6	11.9	1.35	1.62
7	13.5	1.3	1.77
8	15.1	1.5	1.86
9	16.7	1.55	2.13
10	18.3	1.65	2.28
11	19.9	1.7	2.16
12	21.5	1.85	2.02
13	23.1	1.95	2.18
14	24.7	1.95	1.96
15	26.3	2	1.67
16	27.9	1.9	1.5
17	29.5	1.95	1.22
18	31.1	1.95	0.95
19	32.7	1.8	0.7
20	34.3	1.75	0.62
21	35.9	1.55	0.39
22	37.5	1.7	0.32
23	39.1	1.8	0.17
24	40.7	0.5	0.02

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	*Release Flow: 130 cfs*		
1	3.2	0.3	0.13
2	4.8	0.7	1.09
3	6.4	0.95	1.63
4	8	1.2	1.6
5	9.6	1.35	2.05
6	11.2	1.45	2.09
7	12.8	1.6	2.01
8	14.4	1.75	2.45
9	16	1.8	2.89
10	17.6	1.9	3.04
11	19.2	2.05	3.04
12	20.8	2.1	2.9
13	22.4	2.15	2.9
14	24	2.2	2.67
15	25.6	2.2	2.59
16	27.2	2.25	2.24
17	28.8	2.2	1.79
18	30.4	2.25	1.33
19	32	2.2	1.08
20	33.6	2.05	0.85
21	35.2	1.85	0.59
22	36.8	1.8	0.35
23	38.4	2.1	0.31
24	40	1.7	0.21
25	41.6	0.4	0.08
9/21/01	*Release Flow: 150 cfs*		
1	3	0.4	0.64
2	5	0.95	1.4
3	7	1.25	1.75
4	9	1.45	2.21
5	11	1.6	2.49
6	13	1.8	2.61
7	15	2	3.03
8	17	2.05	3.12
9	19	2.2	3.04
10	21	2.3	2.93
11	23	2.35	2.96
12	25	2.4	2.99
13	27	2.45	2.36
14	29	2.4	2.03
15	31	2.4	1.49
16	33	2.3	1.04
17	35	2	0.65
18	37	2.05	0.39
19	39	2.2	0.27
20	41	0.85	0.19

Reported velocities are Mean Column Velocities

Dry Creek Transect 8 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	***Release Flow: 47 cfs***		
1	7.2	0.2	0.13
2	10.2	0.4	0.23
3	13.2	0.5	0.47
4	16.2	0.75	0.59
5	19.2	0.95	1
6	22.2	1.2	1.38
7	25.2	1.5	1.47
8	28.2	1.6	1.8
9	31.2	1.6	1.5
10	34.2	1.35	0.96
11	37.2	1	1.28
12	40.2	0.6	0.73
13	43.2	0.2	0.14
9/19/01	***Release Flow: 90 cfs***		
1	5.6	0.3	0.1
2	8.6	0.6	0.01
3	11.6	0.75	0.24
4	14.6	0.9	0.9
5	17.6	1.1	1.57
6	20.6	1.4	2.16
7	23.6	1.7	2.18
8	26.6	1.95	2.12
9	29.6	2	2.4
10	32.6	1.8	1.29
11	35.6	1.55	1.35
12	38.6	1.1	1.34
13	41.6	0.7	0.59
14	44.6	0.5	0.27

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	***Release Flow: 130 cfs***		
1	4.1	0.3	0.01
2	5.6	0.6	0.07
3	8.6	0.9	0.93
4	11.6	1.15	1.63
5	14.6	1.35	2.57
6	17.6	2.65	2.4
7	20.6	1.85	2.7
8	23.6	2	2.65
9	26.6	2.3	2.66
10	29.6	2.3	1.98
11	32.6	2.15	1.26
12	35.6	1.8	1.52
13	38.6	1.4	1.4
14	41.6	1	0.81
15	44.6	0.85	0.6
9/21/01	***Release Flow: 150 cfs***		
1	4	0.5	0.44
2	8	1.5	1.47
3	12	1.35	2.59
4	16	1.55	2.25
5	20	2	2.89
6	24	2.35	2.65
7	28	2.55	2.52
8	32	2.4	1.39
9	36	1.95	1.59
10	40	1.55	1.06
11	44	1.05	0.74

Reported velocities are Mean Column Velocities

Dry Creek Transect 9 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/13/01	*Release Flow: 47 cfs*		
1	3.75	0.1	0.01
2	5.25	0.1	0.01
3	6.75	0.2	0.25
4	8.25	0.2	0.36
5	9.75	0.35	1.9
6	11.25	0.55	2.11
7	12.75	0.7	2.72
8	14.25	0.85	2.9
9	15.75	1.05	3
10	17.25	1.25	3.03
11	18.75	1.25	3.1
12	20.25	1.2	3.44
13	21.75	1.1	2.73
14	23.25	0.85	2.76
15	24.75	0.55	2.26
16	26.25	0.5	2.49
17	27.75	0.5	1.96
18	29.25	0.45	1.99
19	30.75	0.3	1.29
20	32.25	0.2	0.59
21	33.75	0.05	0.01
9/19/01	*Release Flow: 90 cfs*		
1	2.4	0.2	0.11
2	4.2	0.35	0.09
3	6	0.4	0.37
4	7.8	0.5	0.43
5	9.6	0.6	1.15
6	11.4	0.8	3.66
7	13.2	1	2.66
8	15	1.3	3.01
9	16.8	1.45	3.18
10	18.6	1.5	3.41
11	20.4	1.5	3.6
12	22.2	1.2	3.34
13	24	1	3.15
14	25.8	0.85	2.9
15	27.6	0.8	2.84
16	29.4	0.8	2.31
17	31.2	0.55	2.1
18	33	0.4	1.51
19	34.8	0.25	0.38
20	36.6	0.1	0.01
21	38.4	0.1	0.01
22	40.2	0.1	0.01
23	42	0.1	0.01

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/20/01	*Release Flow: 130 cfs*		
1	2.5	0.6	0.54
2	4	0.6	0.46
3	5.5	0.7	0.4
4	7	0.8	0.83
5	8.5	0.85	0.68
6	10	1	1.47
7	11.5	1.2	2.58
8	13	1.3	2.65
9	14.5	1.5	3.16
10	16	1.65	3.47
11	17.5	1.8	3.56
12	19	1.85	3.91
13	20.5	1.85	3.76
14	22	1.7	3.67
15	23.5	1.4	3.59
16	25	1.2	3.62
17	26.5	1.1	3.5
18	28	1.1	3.26
19	29.5	1.05	3.21
20	31	0.9	3.03
21	32.5	0.8	2.91
22	34	0.7	2.41
23	35.5	0.55	1.98
24	37	0.4	1.58
25	38.5	0.3	0.46
9/21/01	*Release Flow: 150 cfs*		
1	2.5	0.8	0.33
2	4.3	0.85	0.8
3	6.1	1	0.22
4	7.9	1.05	0.84
5	9.7	1.2	1.17
6	11.5	1.35	2.74
7	13.3	1.55	3.09
8	15.1	1.9	3.63
9	16.9	2.05	3.89
10	18.7	2.25	3.96
11	20.5	2.1	4.06
12	22.3	1.95	3.89
13	24.1	1.8	3.55
14	25.9	1.4	3.27
15	27.7	1.4	3.66
16	29.5	1.4	3.57
17	31.3	1.2	3.73
18	33.1	1.05	3.51
19	34.9	0.9	3
20	36.7	0.65	2.59
21	38.5	0.4	0.27

Reported velocities are Mean Column Velocities

Russian River Transect 1 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	***Release Flow: 125 cfs***		
1	4	0.4	0.2
2	6.5	1	0.2
3	9	1.3	1.7
4	11.5	1.4	2.14
5	14	1.75	4.2
6	16.5	1.9	3.69
7	19	2	3.65
8	21.5	2.15	3.19
9	24	2	2.88
10	26.5	1.75	1.7
11	29	1.4	0.8
12	31.5	1.2	0.06
13	34	0.6	0.08
14	36.5	0.15	0.01
10/1/01	***Release Flow: 190 cfs***		
1	4.3	1	0.25
2	7.8	1.55	2.21
3	11.3	1.85	3.39
4	14.8	2.2	3.6
5	18.3	2.4	5.25
6	21.8	2.25	3.97
7	25.3	2.3	2.94
8	28.8	1.9	2.29
9	32.3	1.4	1.29
10	35.8	0.75	0.22
11	39.3	0.01	0.01
10/4/01	***Release Flow: 275 cfs***		
1	4	1.3	0.90
2	8	2.1	3.14
3	12	2.4	4.39
4	16	2.6	4.93
5	20	2.9	5.61
6	24	2.8	3.70
7	28	2.3	3.27
8	32	1.9	1.91
9	36	1.1	0.84
10	40	0.25	0.01

Reported velocities are Mean Column Velocities

Russian River Transect 2 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	*Release Flow: 125 cfs*		
1	3.4	2.15	0.01
2	5.4	2.7	0.01
3	7.4	2.95	0.01
4	9.4	2.9	0.2
5	11.4	2.5	0.52
6	13.4	2.45	0.69
7	15.4	2.8	0.835
8	17.4	2.95	1.32
9	19.4	2.85	1.71
10	21.4	2.85	1.72
11	23.4	2.8	1.755
12	25.4	2.8	1.745
13	27.4	2.75	1.71
14	29.4	2.6	1.73
15	31.4	2.4	1.46
16	33.4	2.05	1.67
17	35.4	1.75	1.67
18	37.4	1.6	1.29
19	39.4	1.05	1.14
20	41.4	0.7	0.49
21	43.4	0.4	0.02
10/1/01	*Release Flow: 190 cfs*		
1	3.8	2.5	0.01
2	7.8	3.4	0.01
3	11.8	2.8	1.25
4	15.8	3.2	1.36
5	19.8	3.25	2.35
6	23.8	3.2	2.58
7	27.8	3.2	2.62
8	31.8	2.7	2.30
9	35.8	2.05	2.26
10	39.8	1.4	1.96
11	43.8	0.7	0.32

Reported velocities are Mean Column Velocities

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
10/4/01	*Release Flow: 275 cfs*		
1	3	2.7	0.015
2	7	3.5	0.025
3	11	3.2	1.04
4	15	3.4	1.32
5	19	3.5	3.225
6	23	3.5	3.42
7	27	3.5	3.455
8	31	3.1	3.27
9	35	2.25	3.56
10	39	1.95	2.78
11	43	1.15	2.67
12	47	0.1	0.01

Russian River Transect 3 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	*Release Flow: 125 cfs*		
1	10.1	0.1	0.01
2	14.1	0.1	0.34
3	18.1	0.3	0.68
4	22.1	0.3	0.96
5	26.1	0.4	0.97
6	30.1	0.5	1.61
7	34.1	0.55	1.44
8	38.1	0.65	1.75
9	42.1	0.65	1.8
10	46.1	0.75	2.29
11	50.1	0.95	2.1
12	54.1	1	2.21
13	58.1	1.1	2.54
14	62.1	1.05	2.65
15	66.1	0.95	2.45
16	70.1	0.95	2.5
17	74.1	0.95	2.57
18	78.1	0.95	2.81
19	82.1	0.85	2.59
20	86.1	0.7	0.49
10/1/01	*Release Flow: 190 cfs*		
1	6.5	0.2	0.17
2	10.5	0.35	0.85
3	14.5	0.45	1.22
4	18.5	0.65	1.13
5	22.5	0.65	1.73
6	26.5	0.8	1.87
7	30.5	0.85	1.96
8	34.5	1	2.04
9	38.5	1	2.67
10	42.5	1	2.5
11	46.5	1.1	2.44
12	50.5	1.2	2.54
13	54.5	1.45	2.54
14	58.5	1.45	2.91
15	62.5	1.4	3.06
16	66.5	1.3	3.13
17	70.5	1.3	3.08
18	74.5	1.3	3.15
19	78.5	1.3	3.21
20	82.5	1.2	2.61
21	86.5	0.9	0.1

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
10/4/01	*Release Flow: 275 cfs*		
1	6	0.4	0.32
2	10	0.6	1.09
3	14	0.7	1.04
4	18	0.85	1.51
5	22	0.9	2.04
6	26	1	2.17
7	30	1.05	2.48
8	34	1.15	2.59
9	38	1.25	2.76
10	42	1.25	2.9
11	46	1.35	2.91
12	50	1.5	2.92
13	54	1.65	2.92
14	58	1.75	3.27
15	62	1.65	3.58
16	66	1.5	3.38
17	70	1.55	3.37
18	74	1.6	3.51
19	78	1.5	3.47
20	82	1.5	2.95
21	86	1.2	0.14

Reported velocities are Mean Column Velocities

Russian River Transect 4 - measured depths and velocities at observed release flows

4A

Station	(feet)	(feet)	(fps)
9/26/01	***Release Flow: 125 cfs***		
1	5	0.15	0.07
2	12	0.1	0.48
3	16	0.1	0.07
4	20	0.15	1.13
5	24	0.25	1.67
6	28	0.3	2.55
7	32	0.6	3.55
8	36	0.7	2.97
9	40	0.65	3.72
10	44	0.75	2.89
11	48	0.75	2.2
12	52	0.9	2.48
13	56	1.3	0.67
10/1/01	***Release Flow: 190 cfs***		
1	5	0.45	0.29
2	10	0.3	1.34
3	15	0.3	0.87
4	20	0.3	1.62
5	25	0.45	3.53
6	30	0.65	4.23
7	35	0.8	4.23
8	40	0.9	4.02
9	45	1	3.96
10	50	0.85	3.97
11	55	1.4	1.74
10/4/01	***Release Flow: 275 cfs***		
1	5	0.7	0.37
2	10	0.4	2.8
3	15	0.4	1.36
4	20	0.4	2.59
5	25	0.45	4.48
6	30	0.6	5.59
7	35	0.8	4.76
8	40	1.05	4.48
9	45	0.9	4.57
10	50	1.1	3.53
11	55	1.5	2.75

4B

Station	(feet)	(feet)	(fps)
9/26/01	***Release Flow: 125 cfs***		
1	3	0.55	0.15
2	7	0.25	1.86
3	11	0.55	1.97
4	15	0.4	1.99
5	19	0.55	0.69
6	23	0.55	1.99
7	27	0.65	1.69
8	31	0.55	1.79
9	35	0.6	1.93
10	39	0.6	1.5
11	43	0.6	1.05
12	45.5	0.9	0.05
13	49	0.55	0.24
10/1/01	***Release Flow: 190 cfs***		
1	4	0.6	0.24
2	8	0.7	2.71
3	12	0.7	3.22
4	16	0.7	3.01
5	20	0.7	2.79
6	24	0.8	2.32
7	28	0.8	2.73
8	32	0.85	2.68
9	36	1	2.65
10	40	0.75	2.6
11	44	1	1.92
12	48	0.9	0.25
10/4/01	***Release Flow: 275 cfs***		
1	6	0.85	2.76
2	10	1	3.32
3	14	0.8	4.28
4	18	0.9	3.76
5	22	1	3.61
6	26	1	2.86
7	30	1.05	3.05
8	34	0.95	3.29
9	38	1.1	3.19
10	42	1	3.04
11	46	1.2	0.04
12	50	0.75	0.42

Reported velocities are Mean Column Velocities

Russian River Transect 4C - measured depths and velocities at observed release flows

9/26/01 Release Flow: 125 cfs

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
1	2	0.8	0.02
2	5	2.3	0.22
3	8	2.7	0.195
4	11	2.85	0.205
5	14	2.9	0.295
6	17	3	0.335
7	20	2.9	0.62
8	23	2.7	0.99
9	26	2.6	1.185
10	29	2.45	1.27
11	32	2.4	0.95
12	35	2.3	0.9
13	38	2.2	1
14	41	2	0.89
15	44	1.9	0.77
16	47	1.65	0.65
17	50	1.6	0.5
18	53	1.35	0.48
19	56	1.3	0.37
20	59	1	0.36
21	62	0.9	0.31
22	65	0.55	0.21
23	68	0.4	0.17
24	71	0.3	0.12
25	74	0.2	0.01

SIDE CHANNEL

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
1	4	0.6	0.08
2	6	0.95	0.87
3	8	1.2	0.88
4	10	0.85	0.63

10/1/01 Release Flow: 190 cfs

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
1	3.3	2.35	0.37
2	7.3	2.2	0.42
3	11.3	2.3	0.4
4	15.3	2.4	0.62
5	19.3	2.7	1.015
6	23.3	2.7	1.365
7	27.3	2.7	1.66
8	31.3	2.7	1.765
9	35.3	2.55	1.645
10	39.3	2.45	1.55
11	43.3	2.35	1.36
12	47.3	2.15	1.23
13	51.3	1.85	1.12
14	55.3	1.7	0.92
15	59.3	1.5	0.96
16	63.3	1	0.85
17	67.3	0.8	0.75
18	71.3	0.7	0.6
19	75.3	0.4	0.44
20	79.3	0.25	0.25

SIDE CHANNEL

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
21	119.6	0.9	0.83
22	121.6	1.4	1.48
23	123.6	0.5	2.03
24	125.6	1.2	0.26
25	127.6	0.45	0.01

10/4/01 Release Flow: 275 cfs

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
1	3.1	1.9	0.54
2	7.1	2.3	0.52
3	11.1	2.3	0.36
4	15.1	2.6	0.42
5	19.1	2.7	1.305
6	23.1	2.9	1.805
7	27.1	2.9	2.035
8	31.1	2.9	2.17
9	35.1	2.75	2.02
10	39.1	2.6	1.835
11	43.1	2.55	1.725
12	47.1	2.3	1.51
13	51.1	2.05	1.3
14	55.1	1.9	1.16
15	59.1	1.65	1.06
16	63.1	1.3	1.09
17	67.1	0.9	1.01
18	71.1	0.8	0.81
19	75.1	0.55	0.78
20	79.1	0.5	0.6
21	83.1	0.3	0.19

SIDE CHANNEL

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
22	118.7	0.65	0.09
23	120.7	1.3	2.07
24	122.7	1.7	2.17
25	124.7	1.6	1.32
26	126.7	0.95	0.06
27	128.7	0.4	0.04

Reported velocities are Mean Column Velocities

Russian River Transect 5 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	***Release Flow: 125 cfs***		
1	14	0.2	0.04
2	20	0.5	1.1
3	26	0.7	1.59
4	32	0.9	1.43
5	38	1	1.62
6	44	0.95	1.49
7	50	1	1.84
8	56	1.1	1.75
9	62	1.1	1.89
10	68	1.15	2.13
11	74	0.8	2.36
12	80	0.35	1.75
10/1/01	***Release Flow: 190 cfs***		
1	10	0.2	0.01
2	18	0.8	1.56
3	26	1.1	2.03
4	34	1.25	1.97
5	42	1.25	2.27
6	50	1.3	2.54
7	58	1.35	2.36
8	66	1.4	2.48
9	74	1.2	2.83
10	82	0.45	2.41
10/4/01	***Release Flow: 275 cfs***		
1	8	0.35	0.22
2	16	0.8	2.26
3	24	1.2	2.5
4	32	1.25	2.62
5	40	1.35	2.74
6	48	1.35	2.7
7	56	1.5	2.92
8	64	1.5	2.72
9	72	1.35	2.98
10	80	0.85	2.86

Reported velocities are Mean Column Velocities

Russian River Transect 6 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	***Release Flow: 125 cfs***		
1	30.5	0.2	0.01
2	33.5	0.4	0.01
3	36.5	0.5	0.01
4	39.5	0.8	0.17
5	42.5	0.9	0.86
6	45.5	0.95	1.2
7	48.5	1.1	0.59
8	51.5	1.15	0.04
9	54.5	1.25	0.06
10	57.5	1.2	0.23
11	60.5	1.2	0.2
12	63.5	1.2	0.28
13	66.5	1.3	0.04
14	69.5	1.5	0.6
15	72.5	1.65	1.17
16	75.5	1.8	1.57
17	78.5	1.9	1.65
18	81.5	2.15	2.1
19	84.5	2.4	2.37
20	87.5	2.65	2.165
21	90.5	2.7	1.495
22	93.5	2.05	0.66
23	95	1.9	0.4
10/1/01	***Release Flow: 190 cfs***		
1	21.1	0.25	0.06
2	24.9	0.4	0.05
3	28.7	0.65	0.01
4	32.5	0.7	0.09
5	36.3	0.95	0.04
6	40.1	1.3	0.31
7	43.9	0.45	0.79
8	47.7	1.6	1.28
9	51.5	1.65	0.83
10	55.3	1.7	0.51
11	59.1	1.65	0.43
12	62.9	1.7	0.56
13	66.7	1.8	0.96
14	70.5	2.1	1.52
15	74.3	2.25	2.08
16	78.1	2.4	2.42
17	81.9	2.7	2.42
18	85.7	3	2.45
19	89.5	3.2	2.17
20	93.3	2.5	0.76
21	94.3	2.45	0.20

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
10/4/01	***Release Flow: 275 cfs***		
1	21	0.55	0.01
2	24.5	0.7	0.02
3	28	0.95	0.02
4	31.5	1.1	0.01
5	35	1.2	0.04
6	38.5	1.5	0.24
7	42	1.7	0.92
8	45.5	1.7	1.21
9	49	1.95	1.39
10	52.5	2.05	1.21
11	56	2	1.04
12	59.5	2	1.09
13	63	2.1	1.15
14	66.5	2.2	1.56
15	70	2.4	1.92
16	73.5	2.6	2.27
17	77	2.7	2.365
18	80.5	2.85	2.45
19	84	3.1	2.7
20	87.5	3.5	2.685
21	91	3.4	1.5
22	94.5	2.7	0.215

Reported velocities are Mean Column Velocities

Russian River Transect 7 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	***Release Flow: 125 cfs***		
1	8	0.45	0.42
2	10.5	1.05	1.09
3	13	1.15	0.93
4	15.5	1.35	0.81
5	18	1.65	1.16
6	20.5	1.9	1.92
7	23	1.9	1.84
8	25.5	1.85	1.77
9	28	1.75	1.67
10	30.5	1.6	1.79
11	33	1.4	1.79
12	35.5	1.35	1.93
13	38	1.35	1.92
14	40.5	1.2	1.92
15	43	1.1	1.69
16	45.5	1	1.62
17	48	0.85	1.6
18	50.5	0.85	1.5
19	53	0.65	1.43
20	55.5	0.6	1.21
21	58	0.35	0.72
22	60.5	0.1	0.01
10/1/01	***Release Flow: 190 cfs***		
1	7.5	0.95	0.1
2	10	1.6	0.99
3	12.5	1.7	0.87
4	15	1.95	0.73
5	17.5	2.2	1.15
6	20	2.45	1.83
7	22.5	2.55	1.71
8	25	2.5	2.015
9	27.5	2.4	2.27
10	30	2.35	2.35
11	32.5	2.1	2.12
12	35	2	2.17
13	37.5	1.95	2.2
14	40	1.75	2
15	42.5	1.7	2
16	45	1.65	2.24
17	47.5	1.55	2.07
18	50	1.45	1.78
19	52.5	1.3	1.99
20	55	1.2	1.63
21	57.5	1	1.48
22	60	0.7	1.02
23	62.5	0.45	0.6
24	65	0.3	0.56
25	67.5	0.3	0.45

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
10/4/01	***Release Flow: 275 cfs***		
1	6	0.8	0.36
2	9	1.7	0.75
3	12	1.9	1.12
4	15	2.25	0.86
5	18	2.5	1.13
6	21	2.75	1.835
7	24	2.9	1.69
8	27	2.7	2.385
9	30	2.55	2.39
10	33	2.35	2.51
11	36	2.2	2.5
12	39	2.15	2.26
13	42	2	2.45
14	45	1.9	2.42
15	48	1.8	2.03
16	51	1.65	2.2
17	54	1.5	1.84
18	57	1.25	1.69
19	60	1	1.38
20	63	0.7	1.12
21	66	0.65	0.49
22	69	0.4	0.12

Reported velocities are Mean Column Velocities

Russian River Transect 8 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	***Release Flow: 125 cfs***		
1	3.5	1.45	1.85
2	6.5	1.7	2.54
3	9.5	1.8	3.36
4	12.5	1.6	3.97
5	15.5	1.4	3.82
6	18.5	1.2	3.44
7	21.5	0.8	2.73
8	24.5	0.65	2.64
9	27.5	0.6	2.05
10	30.5	0.4	0.89
11	33.5	0.1	0.01
10/1/01	***Release Flow: 190 cfs***		
1	3	1.95	0.84
2	8	2.35	3.74
3	13	2.05	5.02
4	18	1.75	4.68
5	23	1.2	4.27
6	28	0.95	3.5
7	33	0.55	2.02
8	38	0.2	0.01
9	43	0.1	0.01
10	48	0.2	0.01
11	53	0.45	0.01
12	56	0.6	0.3
13	58	0.55	0.01
10/4/01	***Release Flow: 275 cfs***		
1	2	1.8	0.59
2	6	2.6	1.865
3	10	2.55	3.58
4	14	2.2	4.9
5	18	2.05	5.06
6	22	1.65	4.6
7	26	1.35	3.94
8	30	1.2	3.49
9	34	0.8	2.17
10	38	0.5	0.21
11	42	0.35	0.5
12	46	0.5	0.06
13	50	0.6	0.05
14	54	0.8	0.68
15	58	0.85	1.05
16	62	0.1	0.01

Reported velocities are Mean Column Velocities

Russian River Transect 9 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	***Release Flow: 125 cfs***		
1	8.6	0.5	0.81
2	9.6	0.3	1.21
3	10.6	0.5	0.89
4	11.6	0.65	1.64
5	12.6	0.4	1.07
6	13.6	0.4	1.85
7	14.6	0.3	3.07
8	15.6	0.2	1.53
9	16.6	0.2	0.19
10	17.6	0.1	0.01
10/1/01	***Release Flow: 190 cfs***		
1	8.4	0.3	0.42
2	9.4	0.65	2.08
3	10.4	0.6	1.9
4	11.4	0.85	1.97
5	12.4	0.8	2.25
6	13.4	0.65	1.49
7	14.4	0.5	3.85
8	15.4	0.35	3.36
9	16.4	0.2	1.79
10	17.4	0.3	0.35
10/4/01	***Release Flow: 275 cfs***		
1	8	0.3	0.1
2	9	0.7	1.19
3	10	0.6	3.12
4	11	0.6	2.4
5	12	0.8	3.12
6	13	0.6	3.8
7	14	0.7	3.51
8	15	0.5	3.15
9	16	0.35	3.28
10	17	0.4	2.02
11	18	0.35	2.28

Reported velocities are Mean Column Velocities

Russian River Transect 10 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	***Release Flow: 125 cfs***		
1	8.3	1.15	1.09
2	11.8	2.1	0.12
3	15.3	1.85	2.8
4	18.8	1.05	3.74
5	22.3	1.6	2.15
6	25.8	1.75	2.19
7	29.3	1.7	2.21
8	32.8	1.3	1.87
9	36.3	0.85	1.59
10	39.8	0.2	0.78
10/1/01	***Release Flow: 190 cfs***		
1	6.8	1	0.65
2	10.3	2.6	0.515
3	13.8	2.35	1.68
4	17.3	2.15	3.75
5	20.8	1.9	0.65
6	24.3	2.2	3.59
7	27.8	2.2	3.44
8	31.3	1.85	2.44
9	34.8	1.4	2.24
10	38.3	0.85	1.68
11	41.8	0.6	0.87
10/4/01	***Release Flow: 275 cfs***		
1	6.5	1.15	1.54
2	10	2.7	0.63
3	13.5	2.45	2.25
4	17	2.35	4.34
5	20.5	2	1.15
6	24	2.35	3.88
7	27.5	2.45	3.45
8	31	2.15	2.48
9	34.5	1.7	2.94
10	38	1.1	1.99
11	41.5	0.75	1.1
12	44	0.2	0.47

Reported velocities are Mean Column Velocities

Russian River Transect 11 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	***Release Flow: 125 cfs***		
1	11.4	1.65	1.3
2	16.4	1.8	3.17
3	21.4	1.55	2.83
4	26.4	0.9	1.74
5	31.4	0.25	1.41
6	36.4	0.5	2.67
7	41.4	0.75	0.96
8	46.4	0.65	1.84
9	51.4	0.8	1.98
10	56.4	0.8	0.08
10/1/01	***Release Flow: 190 cfs***		
1	10.3	1.9	0.08
2	15.3	1.65	3.63
3	20.3	1.5	3.24
4	25.3	1.2	1.75
5	30.3	0.65	1.64
6	35.3	1	1.98
7	40.3	1.35	1.34
8	45.3	1.3	2.81
9	50.3	1.45	2.92
10	55.3	1.5	1.52
11	60.3	0.4	0.04
10/4/01	***Release Flow: 275 cfs***		
1	9.5	1.9	0.44
2	14.5	2.4	4.28
3	19.5	2.25	3.94
4	24.5	1.65	3.65
5	29.5	0.9	3.42
6	34.5	1.05	2.71
7	39.5	1.55	1.72
8	44.5	1.6	3.01
9	49.5	1.6	2.6
10	54.5	1.75	1.6
11	59.5	1	0.04

Reported velocities are Mean Column Velocities

Russian River Transect 12 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	***Release Flow: 125 cfs***		
1	9.5	0.2	0
2	12.5	0.8	0.45
3	15.5	1.2	0.51
4	18.5	1.15	0.52
5	21.5	1.1	1.19
6	24.5	1.05	0.96
7	27.5	0.95	1.26
8	30.5	0.75	1.31
9	33.5	0.55	0.7
10	36.5	0.7	0.95
11	39.5	0.85	1.16
12	42.5	0.8	1.33
13	45.5	1.05	1.8
14	48.5	1	1.87
15	51.5	1	2.13
16	54.5	1	2.25
17	57.5	0.9	2.46
18	60.5	0.95	1.64
19	63.5	0.9	0.64
20	66.5	0.6	1.22
21	69.5	0.3	0.42
10/1/01	***Release Flow: 190 cfs***		
1	5.8	0.1	0.01
2	8.6	0.25	0.24
3	11.4	1	1.18
4	14.2	1.45	1.31
5	17	1.55	1.85
6	19.8	1.5	1.82
7	22.6	1.45	1.91
8	25.4	1.3	2.33
9	28.2	1.3	1.88
10	31	1	2.75
11	33.8	0.9	2.1
12	36.6	1.2	2.42
13	39.4	1.2	3.05
14	42.2	1.15	3.33
15	45	1.2	3.09
16	47.8	1.5	2.92
17	51.6	1.3	3.47
18	54.4	1.3	3.05
19	57.2	1.2	3
20	60	1.25	2.67
21	62.8	1.2	2.01
22	65.6	1.1	1.97
23	68.4	0.9	1.29
24	71.2	0.2	0.01

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
10/4/01	***Release Flow: 275 cfs***		
1	5.5	0.2	0.05
2	8.9	0.4	1.18
3	12.3	1.25	1.57
4	15.7	1.5	1.64
5	19.1	1.75	2.1
6	22.5	1.65	1.83
7	25.9	1.4	2.42
8	29.3	1.3	2.86
9	32.7	1.05	2.09
10	36.1	1.2	2.5
11	39.5	1.3	3.09
12	42.9	1.4	3.15
13	46.3	1.55	3.26
14	49.7	1.55	3.34
15	53.1	1.4	3.22
16	56.5	1.35	2.98
17	59.9	1.35	2.46
18	63.3	1.35	2.28
19	66.7	1.1	1.76
20	70.1	0.6	0.07

Reported velocities are Mean Column Velocities

Russian River Transect 13 - measured depths and velocities at observed release flows

Station	Distance (feet)	Depth (feet)	Point Velocity (fps)
9/26/01	*Release Flow: 125 cfs*		
1	6	2.15	0.08
2	12	3.7	0.12
3	18	2.85	0.635
4	24	2.6	0.7
5	30	1.95	0.96
6	36	1.95	1.18
7	42	1.9	1.85
8	48	1.7	0.84
9	54	1.4	0.23
10	60	1	0.4
11	66	0.4	0.13
12	72	0.5	0.02
10/1/01	*Release Flow: 190 cfs*		
1	4	1.7	0.04
2	10	3.7	0.075
3	16	3.5	0.4
4	22	2.8	0.915
5	28	2.45	1.42
6	34	2.25	2.16
7	40	2.36	1.68
8	46	2.2	2.22
9	52	1.9	1.91
10	58	1.6	0.66
11	64	1	0.03
12	70	0.9	0.13
13	76	0.3	0.11
10/4/01	*Release Flow: 275 cfs*		
1	5.4	2.6	0.05
2	13	4.1	0.2
3	20	3	0.645
4	27	2.7	1.43
5	34	2.4	1.78
6	41	2.4	2.18
7	48	2.25	2.82
8	55	1.9	1.87
9	62	1.25	0.65
10	69	0.8	0.09
11	74	0.7	0.16

Reported velocities are Mean Column Velocities

SUMMARY OF HYDRAULIC MEASUREMENTS AT EVALUATION FLOWS

Stream Name: **Dry Creek**

13-Sep

Transect	Total Discharge (cfs)	Total Area (sq ft)	Total Width (ft)	Mean Depth (ft)	Mean Velocity (fps)
T1	45.71	96.39	58.20	1.66	0.47
T2	39.79	23.10	31.50	0.73	1.72
T2B	39.10	24.08	33.60	0.72	1.62
T3	40.62	34.60	40.00	0.87	1.17
T4	42.52	19.38	30.60	0.63	2.19
T5	41.13	72.80	36.00	2.02	0.56
T6	40.06	32.18	30.75	1.05	1.25
T7	40.52	43.55	35.20	1.24	0.93
T8	41.79	34.95	36.00	0.97	1.20
T9	47.22	18.30	30.00	0.61	2.58

19-Sep

Transect	Total Discharge (cfs)	Total Area (sq ft)	Total Width (ft)	Mean Depth (ft)	Mean Velocity (fps)
T1	79.77	108.50	63.00	1.72	0.74
T2	93.40	36.85	34.00	1.08	2.53
T2B	84.55	36.70	42.00	0.87	2.30
T3	87.51	47.60	40.00	1.19	1.84
T4	95.03	35.55	36.00	0.99	2.67
T5	78.14	89.28	39.00	2.29	0.88
T6	81.90	42.66	31.30	1.36	1.92
T7	77.42	56.24	36.80	1.53	1.38
T8	74.56	48.15	39.00	1.23	1.55
T9	74.40	28.17	39.60	0.71	2.64

20-Sep

Transect	Total Discharge (cfs)	Total Area (sq ft)	Total Width (ft)	Mean Depth (ft)	Mean Velocity (fps)
T1	120.21	122.15	56.00	2.18	0.98
T2	125.41	45.75	36.00	1.27	2.74
T2B	128.54	46.00	40.00	1.15	2.79
T3	132.70	56.10	40.00	1.40	2.37
T4	142.78	46.65	42.00	1.11	3.06
T5	110.74	94.00	36.00	2.61	1.18
T6	120.09	48.48	30.40	1.59	2.48
T7	124.62	70.40	38.40	1.83	1.77
T8	126.80	66.45	40.50	1.64	1.91
T9	114.32	39.45	36.00	1.10	2.90

21-Sep

Transect	Total Discharge (cfs)	Total Area (sq ft)	Total Width (ft)	Mean Depth (ft)	Mean Velocity (fps)
T1	135.08	133.80	57.00	2.35	1.01
T2	149.21	52.60	36.00	1.46	2.84
T2B	158.48	55.10	43.00	1.28	2.88
T3	162.59	64.90	43.00	1.51	2.51
T4	165.21	54.60	40.00	1.37	3.03
T5	139.17	107.80	40.00	2.70	1.29
T6	153.91	59.20	42.00	1.41	2.60
T7	150.30	74.00	38.00	1.95	2.03
T8	146.80	73.00	40.00	1.83	2.01
T9	154.03	49.41	36.00	1.37	3.12

Stream Name: **Russian River**

26-Sep					
Transect	Total Discharge (cfs)	Total Area (sq ft)	Total Width (ft)	Mean Depth (ft)	Mean Velocity (fps)
T1	109.96	46.50	32.50	1.43	2.36
T2	104.24	91.70	40.00	2.29	1.14
T3	114.84	54.60	76.00	0.72	2.10
T4A&T4B	95.08	50.68	97.00	1.05	3.72
T4C	89.80	139.35	78.00	2.85	1.61
T5	100.73	57.30	66.00	0.87	1.76
T6	98.52	97.95	64.50	1.52	1.01
T7	97.31	62.50	52.50	1.19	1.56
T8	103.09	30.75	30.00	1.03	3.35
T9	4.71	3.05	9.00	0.34	1.55
T10	89.53	43.40	31.50	1.38	2.06
T11	95.28	40.00	45.00	0.89	2.38
comminsky flov	96.02	44.63	28.50	1.57	2.15
T12	63.45	52.80	60.00	0.88	1.20
T13	79.00	117.00	66.00	1.77	0.68

1-Oct					
Transect	Total Discharge (cfs)	Total Area (sq ft)	Total Width (ft)	Mean Depth (ft)	Mean Velocity (fps)
T1	183.69	58.14	35.00	1.66	3.16
T2	183.82	103.60	40.00	2.59	1.77
T3	202.92	82.60	80.00	1.03	2.46
T4A&B	197.62	70.35	94.00	1.50	5.63
T4C	172.34	150.50	84.60	2.90	2.09
T5	185.79	80.80	72.00	1.12	2.30
T6	168.72	126.71	73.20	1.73	1.33
T7	173.97	97.75	60.00	1.63	1.78
T8	193.30	53.10	55.00	0.97	3.64
T9	10.63	4.90	9.00	0.54	2.17
T10	141.05	63.35	35.00	1.81	2.23
T11	140.70	60.00	50.00	1.20	2.34
comminsky flov	166.06	62.93	30.00	2.10	2.64
T12	167.55	75.32	65.40	1.15	2.22
T13	156.21	146.66	72.00	2.04	1.07

4-Oct					
Transect	Total Discharge (cfs)	Total Area (sq ft)	Total Width (ft)	Mean Depth (ft)	Mean Velocity (fps)
T1	279.24	73.40	36.00	2.04	3.80
T2	279.73	116.60	44.00	2.65	2.40
T3	280.91	102.00	80.00	1.28	2.75
T4A&T4B	271.80	81.00	94.00	1.74	6.76
T4C	231.57	166.90	90.00	3.13	2.82
T5	243.34	89.20	72.00	1.24	2.73
T6	231.83	155.40	73.50	2.11	1.49
T7	215.06	116.40	63.00	1.85	1.85
T8	236.39	72.40	60.00	1.21	3.27
T9	15.74	5.60	10.00	0.56	2.81
T10	183.72	70.70	37.50	1.89	2.60
T11	232.01	78.75	50.00	1.58	2.95
comminsky flov	203.26	71.48	30.00	2.38	2.84
T12	196.24	83.13	64.60	1.29	2.36
T13	187.90	149.10	68.60	2.17	1.26

ATTACHMENT F

AERIAL PHOTOS SHOWING FLOW ASSESSMENT TRANSECT LOCATIONS